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A NATIONAL UNIVERSITY

THE addresses by Presidents Van Hise and James, published in the August 16 issue of SCIENCE, splendidly set forth the facilities in Washington for advanced study and the reasons for a really national university. The administrative and physical organization, and also the national purposes of the proposed institution, need broad discussion.

Though its promoters might conceive the projected institution as snugly centered in a building beside or as a part of the Bureau of Education, with students directed to attend lectures in one room in each of a few scores of governmental bureaus, and working in the bureau laboratories under the seasoned government scientists, that could not be more than its preliminary stage. The mere name, "University of the United States," backed by the reputation of the scientific bureaus and libraries of Washington, would soon bring such a flood of American and foreign students that the snug executive office would be overwhelmed and the bureaus would be in revolt.

A national university at Washington must be a physical university, with existing bureaus only as adjuncts. History will prove the statement that bureau scientists and equipment can be used only incidentally. Men in charge of research and administrative science, applied to the increasing of production, to policing under pure food inspection or quarantine and other laws, to surveying natural resources, to administering public forest and other business, to promoting the public health, and even to administering educational and gen-

eral public executive affairs, can be teachers and guides to research students only in an incidental way. The number of students would eventually make demands far in excess of that five to twenty per cent. of the energies of each leading scientist which can properly be devoted to graduate students. The university will want the services of only the seasoned workers, nearly all of whom have much scientific and administrative work. While President Van Hise's statement is very true, and admitted by nearly all research workers, that some teaching is a help to the scientists' research work, yet there is always the danger that the teaching will become too heavy. Students come, and the demand on the scientists' time is well nigh irresistible, as is generally proved in case of the workers in the experiment stations in the state agricultural colleges and universities.

These bureaus are even now more effective graduate schools than most people realize. The government bureaus in Washington constitute the most efficient graduate university on earth. The students (employees of the departments) are picked out by the Civil Service Commission and are employed at living wages by Uncle Sam. They enter at once under seasoned scientists into the actual technical work for which they are already in part trained by their college and university education. They are chosen on the basis both of their ability to render service and their promise of developing ability. The average is far more efficient than would be the graduates of our state universities, too many of whom "go on and take yet one more higher course because they have not impressed their teachers that they have the practical ability to succeed" and therefore were not among the graduates at once recommended for positions. This present "working university" gets the young men, and women, who are trained to do things, rather than those who can merely learn of things. These would of course continue to come, but these virile heads of bureaus and laboratories would indeed be loath to devote their time to a dilettante class of rich young men and women of native and foreign birth who come mainly to seek one more degree from the "greatest university."

A flood of these people would not only spoil the work of the departmental bureaus, but would tend to help keep the face of our educational system turned away from the more vital, toward the less vital. Our universities are already too far removed from the people. They so often look down upon the great major industries of agriculture, trades and industries and home-making, that it is refreshing to observe that the universities of Wisconsin and Illinois, over which the two speakers above mentioned preside, are turning the tide and (in the words of derision of a fellow university official) they "are spreading the university all over the state." The dangers to university life from the wealth of its students might easily be much greater in Washington than in any of the second-class universities. It would soon be in a class by itself in size and in the financial resources of its student body. I am not a pessimist, but this, as all other organizations, should be started right. To be started right, it must be built in the interests of the whole people, ninety per cent. of whom are the common people. The individual interests of its students and the interests of the universities from which they come are very secondary matters. The interests of science and of the masses are its real purposes. It must improve and correct wrong educational tendencies rather than enhance them. One of its functions should be to help turn our educational system about so as to be more vital to that

ninety per cent. who are our productive classes and home makers.

Its functions can not rightfully be to merely produce men and women with so-called higher education, as too many of our higher schools of learning have too much contented themselves with doing. Recognizing that an educated aristocracy is little better than a money aristocracy, it must train people for such specific forms of service as the times require. It must train individuals, not primarily for their own interest, but that through research, invention, teaching and other forms of leadership the whole people may be made more efficient and successful. It must train workers in lines especially needed for the public good. It must not merely duplicate the state universities and colleges, but must supplement them by taking up lines they can not or will not undertake. While holding to the grade of master's degree for entrance requirement may seem a technical necessity from the mere viewpoint of the interest of the state university, yet why deny the fostering direction of such an organization to a woman, who as mother and public worker, though not a graduate, has become highly qualified to do advanced work in relation to woman's work or to children? Would it be wise to bar a man who through greatly beneficent labors for the farmers, even including a state and national legislative experience, from coming here to further equip himself for his chosen form of science or other public service? Why debar the labor leader, who has graduated in valiant and successful campaigns for the working people, because his master's degree did not come from a university? I am sure that Presidents Van Hise and James will be the last of all university presidents to run around in a circle on this matter of the breadth and depth of a national university when the whole subject is "before the house." Surely some way can be found, broader than mere graduation in a college or university, for determining who can use the facilities of the university to advantage. Achievement, not mere study, native adaptability and need, practical experience, self cultivation, along with school preparation, and promise of unusual power for public service, should be considered in selecting those eligible to use the offered opportunities for the common good.

The passing of the era of confining educational propaganda mainly to the discussion of higher education, so-called, and the entrance of the discussion of vocational education for the masses, places the discussion of any proposed university upon an entirely new plane. The educational sun has begun to shine down where most of the folks live. Their clouds are clearing away, and the light of modern science and benefits are not confined to the higher regions, educationally. The farmer, the man at the machine, the shop foreman and the mother in the home, are to have technical training, as well as the lawyer, the doctor, the preacher, the teacher and the technician. It will be different, to be sure; a larger part will be practical, but it will be substantial and effective in increasing the production and the remuneration, as well as the enjoyment, of the ninety per cent. Incidentally it will benefit also the professional classes; just as their education enables them to be of service to those who labor in the major industries and in home making, the technically educated masses will be of greater service to the professional classes.

A national university devoted simply to the interests of higher education might proceed to become a joke among folks who work for the masses. To place the possibilities of such an institution in the hands of administrators and teachers who see only

abstract science and professional interests would rob it of the larger share of its possibilities. With a vital connection with the mass of people it will be on a basis of service and growth of marvelous proportions. Secretary Wilson has shown the qualities of largest university administrative sense, in sending his young workers out to the work, wherever found in America or other continents, that they might be "seasoned" for their work in the broadest possible way. No other administrator at any time has built up such a corps of seasoned men, very many of whom have been supplied to universities and experiment stations in this country and abroad. The proposed university must touch the present problems of the people, else it will become academic and pedantic, and will be attended because its certificates are valued as a matter of fashion or family pride.

The atmosphere of science and art is becoming more and more vocational and democratic. While "pure science for science sake" is growing in number of workers and in character, applied science is growing much the more rapidly. There is much of both at Washington, and a national university should recognize every phase of both. And why should it not especially deal with those phases of science, art and citizenship, which deal with national life and the life of the whole people? A division of labor would place with the universities in the states matters of local concern and with the national university matters of interstate, national and international concern. Such an institution in this greatest of nations might in many ways function as an international institution. And why should it not receive, from private sources, endowments for international functions? Among these could be the creation of commissions, financed under the guidance of the university, to study international problems. As examples of these problems, the following are worthy of suggestion:

- World-wide atmospheric and weather investigations.
- Studies of the seal and fishes which inhabit the high seas.
- Birds which are international in their habit.
- World area statistics of crop conditions, acreages, harvests, stocks in transit and in store and prospective demand; and in connection therewith the international relations of markets which deal in margins on options and futures and thus place the ownership of margins along with crop conditions as factors in determining prices.
- The welfare of labor which periodically crosses international boundaries.
- International relations of currency plans.
- Eugenic factors needing regulation in immigration.

Other endowments, made by the public or by private parties, might deal with very many interstate matters which can not so well be studied by local universities. Even a general scientific inquiry as to the reapportionment of functions between the federal and state governments might here be made. A study might be made of all our voluntary economic and fraternal associations. The legal department might properly lead in developing the principles of cooperative law as different from corporate law—laws under which cooperative forms of production, transportation, distribution, etc., would be encouraged, with a view to the democratization of much business now becoming less democratic under the corporation laws which make for business autocracy. Here vocational education might be studied with a view to broadening out our educational system to produce at once stronger citizens and more efficient producers of wealth and makers of better homes. Our state, national and international judicial system might here be studied with a view to ex-

pediting procedure and better insuring justice and equity.

Here the academic side of the work of many governmental bureaus and commissions could be broadly studied, with the aid of the men who are in the midst of administrative experiences. Thus help might be given to the work of the Interstate Commerce Commission, the State and National Food and Drugs Board, the Census Bureau, the state and national geological surveys, the Patent Office, the Pension Office, the Plant and Animal Breeding sections of the Bureaus of Plant and Animal Industry, also the Meat Inspection Service, the Forest Service, the Biological Survey, the Labor Bureau, the Bureau of Standards—but there are too many to enumerate.

And why should such a university not find ways and means of serving the great national voluntary organizations, such as the American Federation of Woman's Clubs, the American Federation of Labor, the Chamber of Commerce of the United States, recently established in Washington, the National Education Association, the reorganized Farmers National Congress, the American Breeders Association, and the American Manufacturers Association? That a really national university represent all interests, there is need that it be under guidance by the people, not by mere academicians nor by politicians. Mr. Bush-Brown's proposal that the regency be in part nominated by the great federated bodies of voluntary nonprofit earning societies of the people, as those mentioned above, and in part chosen by the President, would accomplish this need.

Such a method of uniting for a common purpose to study and reach the truth concerning questions affecting all classes would be the beginning of a broader viewpoint among all classes, as between capital and labor, between producer and transporter, between farmers and manufacturers. The presence of a representative of the American Manufacturers Association would insure the cooperation of that body. The presence of a woman from the American Federation of Woman's Clubs would insure greater activity in research so greatly needed in relation to home making. The presence of a representative of the American Federation of Arts would insure that the major arts of expression, as oratory, music, painting and sculpture, would be given a larger leadership. A member representing genetic organizations would help to bring forward eugenic, as well as euthenic, improvements in the race. Labor and capital would here be welded together in a flux of scientific facts. The presence of representatives of religious, ethical and political economic organizations would not only soften down animosities but would aid in bringing about an equitable division of wealth and more nearly uniform opportunities for all. Thus it would not be an over-university, dominated by an aristocracy of wealth and an aristocracy of education. Its roots, through these associations of the people, should go deeply into the lives of the masses who work and make our homes.

Instead of rooms in a building beside the Bureau of Education, it should be a great institution on a large tract of land. This land nearby can not be secured a hundred years hence, and it must be within a ten minutes' rapid transit trip of the departmental laboratories on and in the vicinity of the Mall. To wait to purchase land will make impossible the future greatness of the institution, and who knows but that it may not be a world institution? A few millions invested in land will be its greatest assurance of a broad basis and of a wonderful future. A goodly allowance of land will give opportunity to here work out much

that is needed to improve the outdoor recreational life of our people. When a hundred millions have been multiplied our population will more and more need leadership in the joy of living. Land will permit of instruction, outdoor laboratory work and practical experience in genetics, the creation of new forms of plants and animals by breeding, and other intense forms of agriculture and for recreation and outdoor art. Some of this can be so carried out as to give inspiration to the millions of sightseers from the states and from abroad.

While much can be arranged in way of part-time courses, as between the university and the governmental bureaus, much more of this practical mixing of real experience and schooling can be carried on in cooperation with factories, farms and other economic and professional work in all parts of the country and abroad. The local universities can be a party to many of these part-time courses. This will make it possible to use the government bureau workers as teachers only rather incidentally. It will permit the university and departmental authorities to cooperate in the division of labor of its workers. In many cases, in part owing to temperamental character, some workers should teach only; others should work only at research. In other cases the teacher or the experimenter should do only a minimum of service in another line than the one which is his or her major interest.

There will doubtless be found ways of getting away from the idea that a national university is primarily an agency to supplement state and other local universities. These institutions too long have held the high schools in line to serve the needs of the few who enter the colleges and universities, rather than the needs of the many who leave the high school and lower schools to enter practical life, thus confining vocational education to the professions, as if they had rights to be an aristocracy. The service to the public will be the large work of a national university, and service to the local universities will be only a very important incident.

For example, if the nation wants men trained for its service it will not want to confine itself to "master" graduates, especially if there are not a sufficient number presenting themselves, or if these are not of as good timber and promise as men chosen in part from other sources. For example, the State Department might desire to provide that men grown up in the consular and diplomatic service be given special lines of instruction to further prepare them for their work. The Department of Agriculture might need a winter school for its workers in farm demonstration, and for home extension teaching (it is now in great need of the finished products of such a school). Moreover, such bureaus as the Census, Agricultural Statistics, Fisheries, Indian Affairs and the Geodetic Survey, require men which, owing to the small need in any one state, are not trained in local institutions. Such a national university would properly take time by the forelock and prepare men for service in international or world governmental departments so as to be ready when world peace comes. Thus the International Institute of Agriculture at Rome will require men versed in world area crop statistics and other similar service—and no university has anticipated the demand for workers along these lines. The public requirement runs all the way in grade from secondary to graduate work preparation. Then there is the demand in the district for an undergraduate institution, such as would be provided if congress accede to the District's request for the privileges granted each state under the A. and M. land grant

College Act, which might properly be a part of a national university.

No greater boon has come to some of our universities, for example, those in Wisconsin, Illinois and Minnesota, which have secured means for such large service, than has come through college extension departments to serve those not resident in schools, to the mature farmer, mechanic and home maker. And the federal government already has in hand a stupendous work of this kind in its bureaus of farm demonstration and farm management. A national university, with its regency in part nominated by the great federated bodies of societies representing all phases of industry, home-making, education and art, might here have its greatest function. Mr. Bush-Brown's idea of a people's education foundation under the auspices of such a board would probably grow into a vastly greater work than the service to students resident in Washington.

Such a foundation could federate with all the private foundations, the national and state bureaus of education, the educational institutions of all states and the federated bodies supplying members to the regency for the most effective educational service. Under its guidance our educational machine (shown by the Carnegie Foundation and the General Education Board to be so disjointed and poorly coordinated) would be made vastly more efficient. Private fortunes would come to such a foundation, with its semipublic plan of control, and at the same time congress might find reason to provide liberally for its needs along all lines clearly meeting public demands.

It is manifest that this subject needs more discussion. The possibilities are so very large that wide consideration should be given that the more essential factors be brought boldly to the forefront. A move now to establish a university will make a new era in higher education. But one of its chief lines of work should be to foster vocational education for all the people in the lower schools. The better the lower schools are in giving efficiency to the producing classes, the more financial support and the more well-prepared students will come to all universities. But that is a small consideration beside the one of providing vocational education just below those rounds of the educational ladder from which the masses actually do and will leave to enter the work of producing and home-making. A board of regents in large part selected by and from the various classes of people, and a public educational foundation, supplied with means through which such a regency can reach and guide and build up the masses, will make not a Washington institution, but a national university; not a campus college but a university spread all over Uncle Sam's domain; and may become a beneficent world foundation to help take our freedom, our ideals and our opportunities to all the people in all the world.

WILLET M. HAYS

UNDERGRADUATE RESEARCH WORK IN MEDICAL SCHOOLS

IT has undoubtedly become true that a man with a real desire to gain all he can from his four years in the better type of American medical school can not be free very long from the idea that he must know something of the methods of investigation in medicine, or else graduate lacking an important element in his training. I am not referring to the man who feels he will favor the world with a cure for cancer as soon as his osteology course is finished, but to the steady well-prepared workers who make up the first third of every medical class. These men find themselves launched

on a traditionally inspiring sea. They are far too acute not to know that their strongest leaders are the imaginative, productive spirits in their new life and they want to follow the best. It is not amiss for such men to feel they have a right to gain some notion of what investigation entails. Such information is gathered to some extent in the laboratories of the first and second years, but in most instances it is to a very small extent. The doing of fixed experiments in fixed hours does not entail the exercise of investigative faculties other than those of the most mechanical nature. The student receives instructions as to the setting up of apparatus and the preparation of his material. If he follows these faithfully and accurately he is reasonably certain of gathering the data for the necessary conclusions. Perhaps from his primary deductions he is required to generalize some governing principle of the widest application. At best he has had almost no chance for the use of his imagination; he has never learned the meaning of high scientific accuracy. He has no true notion of the difficulty of putting a problem on a working basis. I believe it must be the lack of just such powers which leads to the adverse criticism of so many American students in German universities.

The student more or less realizes these facts and when in his third and fourth years he finds he can get access to the laboratory most attractive to him, he takes his scraps of time and does what he can. Is it worth while to meet him half way?

Six years ago the medical students of the University of Pennsylvania organized the Undergraduate Medical Association, modeled upon the American Medical Association, and having for its constituent parts the numerous medical societies which are a constant part of student life. The organization planned one large meeting a year, when original papers were to be presented. The success of the meetings has varied considerably. This, as will appear later, must necessarily be so. Fourth year men do the largest part of the work, beginning in their third year and finishing the following April. If they are to do anything worth while they must expect to pay the price of slackening in their other work, and it occasionally happens that there are not many men in a class who dare to do this. I do not believe it ever happens that there are not many who would be glad of a chance to do some independent work, but, as a rule, under the circumstances of an inflexible curriculum, there are not enough who dare to carry this to a successful conclusion.

Such men receive all possible encouragement from the faculty, and in reason they are given every facility for their work. But the assistance never takes the vital, practical form of *time to work*. The student investigator must keep abreast of his fellows and do his experiments when he can. With the present medical course this "when" requires considerable research for the discovery of its existence. Since such a situation must unfailingly hamper the activity of the Undergraduate Medical Association it was decided to attempt to better it, and with the encouragement and help of Dr. Allen J. Smith, the dean of the faculty, the following investigation was undertaken.

Twenty-five medical schools were selected as a basis of investigation. It is evident from the lists given that they represent fairly well the various types of effort in the field of medical education. The deans of these schools, with the exception of Johns Hopkins, received the following letter and questions. In the case of Johns Hopkins the letter was sent to Dr. W. H. Howell, and his reply must be

regarded as the expression of a personal opinion rather than an official statement from his school. The deans of two other medical schools, Cornell and the University of Toronto, failed to respond to the first letter, and in these two cases a second letter was sent to selected professors, Dr. James Ewing in the one case, and Dr. J. B. Leathes in the other.

PHILADELPHIA, PA., April 22, 1912

DEAN OF THE MEDICAL DEPARTMENT,

Dear Sir: It is the contention of some of the undergraduates of this school that certain carefully selected men should be given permission and special privileges in the working out of research problems. At the present, while post-graduate research is favored in every way, undergraduates are allowed no deviation from the regular curriculum and little opportunity for original investigation. Before any changes are made in the present system it has been suggested that inquiry be made into the status of undergraduate research work in other schools. With this in view I have prepared the accompanying list of questions, to which I request the favor of a reply, together with any further suggestions or comments which you may care to make.

Thanking you, I am,

Very truly yours,

CECIL K. DRINKER, *Chairman,*
Research Committee of the Undergraduate Medical Association of the University of Pennsylvania

QUESTIONS

1. Do you allow undergraduates to undertake research in conjunction with their regular medical work?
2. Do you give such men any immunity from work in their regular courses?
3. How do you select men for such work—is it done entirely by the department to which they apply or do you have a faculty committee to deal with such applications?
4. Do you believe that the original work turned out by these men justifies the time they have taken from their course?
5. Do you believe that the care your faculty has taken to produce and further such work has resulted in your school turning out effective laboratory men in larger proportion than it would have without such a policy?

DISCUSSION OF THE FIVE QUESTIONS

First Question

Do you allow undergraduates to undertake original research in conjunction with their regular medical work?

Seventeen colleges out of the twenty-five give an affirmative answer to the first question. They are:

1. Albany Medical College.
2. University and Bellevue Hospital and Medical College.
3. University of California.
4. University of Cincinnati.
5. Cornell University.
6. College of Physicians and Surgeons of Columbia University.
7. Harvard University.
8. Johns Hopkins University.
9. University of Michigan.
10. University of Minnesota.
11. Northwestern University.
12. Rush Medical College.
13. Tulane University.
14. University of Virginia.
15. Washington University.
16. Western Reserve University.
17. Yale University.

Eight colleges answer in the negative. They are:

1. Atlanta College of Physicians and Surgeons.
2. Jefferson Medical College (permits in the summer).
3. McGill University.
4. University of North Carolina.
5. University of Pittsburgh.
6. University of Tennessee.
7. University of Texas (permits in the summer).
8. University of Toronto.

Therefore, in all, seventeen schools permit undergraduates to undertake research and eight do not. If we classify all these schools upon the basis selected by Mr. Flexner in the first report of the Carnegie

Foundation on Medical Education, namely upon the possession or lack of a two years' college entrance requirement, we find that of the schools permitting undergraduate research five fail the test:

1. Albany Medical College.
2. University and Bellevue Hospital and Medical College.
3. University of Cincinnati.
4. Tulane University.
5. University of Virginia.

If we examine the other side we find not a single school meeting the Carnegie requirement. Some of the schools giving negative replies make it clear in their letters that they do not indulge in the policy of furthering the research spirit because of the need of the country for "practical men" or "capable family doctors." It is difficult to conceive however of a really "capable family doctor" who can not think scientifically, or of a "practical man" without practical facility in the scientific investigation of his cases.

Question Two

Do you allow such men any immunity from work in their regular courses?

We find only one school, Tulane University, going to the extreme indicated by the question. Their attitude is best explained by extracts from the letter of Dr. Isadore Dyer, the dean.

Answers to questions one and two:

1. Undergraduates in their last three years are encouraged to do original research in conjunction with their regular medical work. As yet there has been no systematization of this kind of work in the Tulane Medical Department and, so far, the men undertaking such work have been compelled to forego a part of their regular curriculum.

2. In the fourth year men are assigned to the laboratories of pathology and clinical medicine as assistants and, in such capacity, are not only permitted but are encouraged to do original work. In their capacity as assistants they are excused from other work which might interfere with such function.

One can not help feeling that a similar condition exists in other schools, but brought about in a different manner. Suppose a medical course contains a certain number of elective hours—elective in the sense that they may be filled by extra routine work in the various subjects of the course or by research. Men must complete a certain number of hours or units to graduate. They are given no "immunity from work in their regular courses," but they do not need it, since they can make a successful research a factor in getting the degree, quite as well as the passing of an examination in some required subject.

The question, therefore, takes a broader basis and becomes: What schools make undergraduate research possible by a concession of hours in the regular roster? Nine schools answer such a question affirmatively. They are:

1. University of California. This school announces that

> the more proficient students are encouraged to do advanced work in the line of original research, particularly in anatomy, physiology, pathology and experimental surgery. (Letter of Dr. A. A. D'Ancona.)

The catalogue shows a roster of sufficient elasticity to allow successful work.

2. Harvard University. No free hours are given until the fourth year, when the following arrangement is made.

> The electives of the fourth year are given as half-courses and quarter-courses. A half-course occupies the entire day for one month (the all-day plan) or the forenoons or the afternoons for two months (the half-day plan). Each half-course has a value of one hundred and twenty-five hours. Quarter-courses occupy half the day for one month. Two quarter-courses equal a half-course. Eight half-courses are necessary to satisfy the requirements of one thousand hours of work demanded in the fourth year.
>
> Students wishing to specialize in any particular branch of medical studies may elect more than one of the half-courses offered in a given subject, but

no student will be allowed to devote his whole year to one subject without the consent of the head of the department concerned.

When a student's research work in an elective is necessarily prolonged beyond the time elected for that subject, he will be allowed, with the permission of the Administrative Board, to make such changes in his electives as will enable him to finish his research work, provided the time required does not extend beyond the school year. (Catalogue of Harvard University Medical School, 1911–12, p. 55.)

3. Johns Hopkins University. In the first two years we find that

the major portion of the work of these years is obligatory for all students, but the time is so arranged that certain elective courses may be selected; thereby making it possible either to give more time to the obligatory courses, or to do special work along the related lines. When any elective course has been selected it must be completed satisfactorily if credit is to be obtained for it. (Johns Hopkins University Catalogue, 1911–12, p. 116.)

In the third year

on certain afternoons there are also offered a number of short elective courses of a practical character, and each student is required to select from them a sufficient amount of work to give him a credit of one and a half units—the unit for the last two years being defined as a course or group of courses equivalent to six hours a week for one trimester. (Johns Hopkins University Catalogue, 1911–12, p. 117.)

In the fourth year the class is divided into three groups, each working in rotation for one trimester in medicine or surgery, or in certain elective courses. For one third of their time the students are given an opportunity to vary their studies according to their special needs and may choose from a large number of elective courses. (Catalogue, p. 117.) The courses so elected may continue the practical work in medicine, surgery, obstetrics, gynecology, etc., or may bear upon the special branches of medicine, or may be taken in the scientific laboratories. Each student, in other words, after completing certain minimal requirements, chiefly in medicine and surgery, may extend his knowledge by taking a number of short clinical courses in different departments, or he may concentrate his attention upon the work of a few departments. (Catalogue, pp. 118–119.)

A quotation from Dr. Howell's letter is of interest:

The committee controlling the work of the first two years decided also that students who had shown inability to carry the required work successfully, as shown by their marks, should not be permitted to engage in advanced or research work.

4. University of Michigan. In the first year an optional course in topographical anatomy is given from April 15 to the end of the term. At the same time stipulation is made that

students desiring to follow a laboratory career may substitute other work for the latter course by applying to the professor of anatomy. (Michigan Catalogue, 1912–13, p. 25.)

Other opportunities are given in anatomy, introduced by the following paragraph:

It should be pointed out that in addition to the information and technique acquired in their accomplishment, the special study of such problems possesses the additional value of developing independent thought and the work is strongly recommended to all students planning to follow a university or laboratory career. (Michigan Catalogue, 1912–13, p. 28.)

The same principle holds for the three following years. Saturday work is not required except in the third year, and the students are thus given a fair allotment of time for independent work and thought. The letter of Professor Victor C. Vaughan sums up the Michigan attitude:

1. We not only allow, but encourage undergraduates to undertake research work, provided they have good standing in their regular work. They must not, under any circumstances, shirk their regular work in order to do research.

2. We do not give immunity from the routine work to those who do research. During the fourth year there is one period of three months in which the bright student has half the day to do research work. In addition to this, many students do some of their ordinary work in the summer session, and in this way get from six to eight weeks ahead of the class. This time they may devote to research work. (Extracts from letter received May 9, 1912.)

5. Rush Medical College. Elective courses are given in all four years. The quarter system in vogue in this school is so essentially elective and gives such great latitude in the whole school career that it is useless to try to give any adequate notion of how much time a man may be permitted to spend on research.

The letter of Dr. H. Gideon Wells expresses the situation excellently.

> We have always laid the greatest stress on research work by undergraduate students in the medical courses. This is not a new thing, but dates back to 1895. Since that time there have always been several undergraduate students engaged in research, at first chiefly in the department of pathology, but since the university took up medical work eleven years ago, in all departments. We not only permit research by our students but encourage it in every way possible. We even send notices to the colleges throughout the country from which our students come that we offer prizes for undergraduate research work, and I enclose a copy of the same. I am pleased to announce that negotiations are now under way whereby an additional cash prize of $200 will be awarded annually for undergraduate research in pathology or bacteriology.
>
> We do not excuse research men from any of the ordinary courses, but we do not stuff our curriculum so hopelessly full of required work that capable and energetic young men can not find time for original investigations, and commencing next year one quarter is left entirely open for elective work. Our quarter system permits of much elasticity in the curriculum, and a man with the research spirit is usually willing to put in extra quarters at work, the university being open all year. Most of the best men in our first two years do research work or assist in it, and a considerable proportion spend from one to three years extra time between the second and third years of the medical courses, in working for a master's or doctor's degree. I always have a class of from six to ten men who are candidates for the degree of Ph.D., taking either their major or minor in pathology. The men who do the work either request the privilege or are selected by the departments, most of them receiving aid in the form of fellowships or scholarships from the university.

6. Tulane University. Dealt with on page 54.

7. University of Virginia. Here we find that

> opportunities are offered in the fourth year for more extended training in certain subjects with a view towards possible specialization after graduation. (Catalogue University of Virginia, 1911–12, p. 199.)

These opportunities are given in physiology, pathology and bacteriology, and mean six hours a week for half a year. Four students only may be taken in physiology.

An extract from the note of Dr. R. H. Whitehead is as follows:

> Our curriculum is planned for the "average man," and it keeps such a man quite busy; he can hardly do anything else to advantage. But the exceptional man can often undertake some line of investigation with results that are distinctly beneficial to him and creditable to the school.

8. Washington University. Elective courses are given through the four years. Specially qualified students are permitted, at the discretion of the heads of the departments involved, to take up original research instead of these electives. They can obtain units for graduation by means of such work.

9. Yale University. Elective courses are given in all four years. The requirement of a thesis for graduation necessitates a certain amount of open time through the course and men may make original work the basis of the thesis.

Schools permitting research and giving no visible time for it are as follows:

1. Albany Medical College.
2. University and Bellevue Hospital and Medical College.
3. University of Cincinnati.
4. Columbia University.
5. University of Minnesota.
6. Northwestern University.
7. Western Reserve University.

Of these schools Columbia, Minnesota, Northwestern and Western Reserve meet

or more than meet the two years college entrance requirement.

When we add to these the eight schools which do not permit research or allow it only in the summer, namely:

1. Atlanta College of Physicians and Surgeons,
2. Jefferson Medical College,
3. McGill University,
4. University of North Carolina,
5. University of Pittsburgh,
6. University of Tennessee,
7. University of Texas,
8. University of Toronto,

we have grouped the lukewarm and negative side of the whole proposition. Not one of this last group requires two years of college work.

Third Question

How do you select men for such work—is it done entirely by the department to which they apply or do you have a faculty committee to deal with such applications?

Tulane University requires that research men, after being passed upon favorably by the department to which they have applied, obtain the consent of the dean and president of the university. All other schools have the selection in the hands of the departments alone.

Without going into every answer, it may be given as the strong opinion of all the schools that only certain men should be allowed to undertake original investigation. Where there are elective hours which may be filled by research, it is always carefully stated that the selection is controlled by "previous standing," "special fitness," etc., so that those who would probably become unsuccessful investigators are barred from starting and take other elective hours in line with the regular work. The whole policy of furthering undergraduate research is, therefore, levelled at a small number of men, and it is most significant to know that many of our greatest schools find it worth while to pursue such a policy.

My answers to this question emphasize another fact. Research spirit is fostered by example, not by coaxing. Free hours are given which may be filled by research, but permission to so fill them is in the nature of a prize. As Dr. Howell says, "the researchers become marked men," and Dr. Christian,

> The medical curriculum should be elastic enough to allow each student a certain amount of time which he may occupy in accordance with his own ideas. Most students will and should occupy this time in studying a little deeper some of their regular subjects. The occasional student will occupy it in some form of investigation. The latter type of student, I am inclined to think now, finds time for investigation. [Note, page 55, Harvard gives more chance for such students than any other school except Rush.] You can not create such students by any rule. Any systematic move to develop research work among the students appears to me, on the whole, to be farcical, because original investigation is not so produced. No student should be encouraged to neglect his regular work for investigation. The brighter student can do his original work after he has kept pace with his classmates.

This expresses the view which should be taken of the whole matter. It does not come from a school where undergraduate research is forbidden nor where it is made an ornament of the catalogue, but from one which furthers it in every way in the right men. That is the inevitable conclusion from this study—not unlimited, uncontrolled hours, which is the meaning of the word *elective* to most people, but controlled and counted hours for men who must justify their selection or suffer from their failures, just as men must suffer who do not do their work in any one of the prescribed courses.

Question Four

Do you believe that the original work turned out by these men justifies the time that they have taken from their course?

Affirmative answers from:

1. University of California.
2. Johns Hopkins University.
3. University of Michigan.
4. Northwestern University.
5. Rush Medical College.
6. University of Virginia.
7. Washington University.
8. Western Reserve University.
9. Yale University.

The following do not answer the question:

1. Albany Medical College.
2. Atlanta College of Physicians and Surgeons.
3. Jefferson Medical College.
4. Harvard University.
5. University of Minnesota.
6. University of Texas.

Negative answers come from:

1. University and Bellevue Hospital and Medical College.
2. University of Cincinnati.
3. Cornell University.
4. Columbia University.
5. McGill University.
6. University of North Carolina.
7. University of Pittsburgh.
8. University of Tennessee.
9. Tulane University.
10. University of Toronto.

Opinions upon the question from several schools are as follows:

Dr. Howell (Johns Hopkins):

Some men have told me that their experience in research was of the greatest value—an intellectual awakening. I have known of others who have fallen by the wayside and made the instructor himself feel that the time was wasted. On the whole all of us believe in its value, otherwise we would discourage it—not, I fancy, for the value of the scientific results obtained, but for its educational value on the picked men and the belief that the group of the serious workers in medical science will be recruited from this body of students.

Dr. H. Gideon Wells (University of Chicago):

There can be no question as to the value of the work which has been turned out by our undergraduate investigators, but that is a very secondary consideration compared with the influence on the men themselves.

Dr. Victor C. Vaughan (University of Michigan):

Some very good original research has been done by our undergraduates. We have what we call the Junior Research Club, made up principally of assistants and students and encouraged by members of the faculty.

Dr. I. H. Manning (University of North Carolina):

In my judgment the student is unprepared to do creditable original work.

Fifth Question

Do you believe that the care your faculty has taken to produce and further such work has resulted in your school turning out effective laboratory men in larger proportion than it would have without such a policy?

Affirmative answers come from:

1. University of California.
2. Harvard University.
3. Johns Hopkins University.
4. University of Michigan.
5. Rush Medical College.
6. University of Virginia.
7. Washington University.
8. Western Reserve University.
9. Yale University.

Schools giving no answer are as follows:

1. Albany Medical College.
2. Atlanta College of Physicians and Surgeons.
3. University and Bellevue Hospital and Medical College.
4. University of Cincinnati.
5. Jefferson Medical College.
6. University of Minnesota.
7. University of North Carolina.
8. Northwestern University.
9. University of Texas.
10. Tulane University.

In regard to Tulane the answer of Dr. Dyer is as follows:

The policy above indicated has been too recent to justify any reply to your fifth question, but it is my personal belief that the sympathy of the faculty with the research spirit in students is bound to make better laboratory men. More than

this the demand for men trained in the laboratories as now obtains in the south and will obtain hereafter, makes it more than a policy for the future.

Schools answering in the negative are:

1. Cornell University.
2. Columbia University.
3. McGill University.
4. University of Pittsburgh.
5. University of Tennessee.
6. Washington University.

Certain interesting opinions are as follows:

Dr. Howell (Johns Hopkins):

I have no doubt whatever that the custom as it exists in our school has been responsible in determining the course of a large proportion of our men who have subsequently undertaken investigation as a life work.

Dr. Vaughan (University of Michigan):

I am quite sure that the encouragement given to our brighter students to do research work has resulted in drawing out many more effective laboratory men than would have been the case had we not encouraged research.

Dr. H. Gideon Wells (University of Chicago):

Nearly all the investigators who have graduated from Rush Medical College have done undergraduate research work, and I would criticize your question 5 to the extent of saying that the research work turns out more efficient practitioners as well as laboratory men, for a practitioner should look on each case as a problem for investigation and approach it with the same spirit that a laboratory man approaches his problem.

Dr. George Dock (Washington University, St. Louis):

Probably yes, but it is impossible to say positively. The fact that graduates are active investigators should stimulate just as many men to take up laboratory careers after graduation. In some cases premature work in investigation has kept men from getting a good grounding.

Dr. Samuel W. Lambert (Columbia):

I doubt very much if any special results can be traced to such a course.

In summing up the whole matter, I think it is evident that there is a decided tendency in the foremost schools to give time in the curriculum for independent work and thought, and the tendency to turn certain men to a laboratory life as well as to the better type of medical practise. Dr. Lambert, in replying for Columbia, one of the schools giving a pronounced negative throughout, adds to his letter:

I would here state that the committee on scholarships recently recommended to the faculty beginning next fall, "that four awards of $350 be made to undergraduate students; that holders of these scholarships be assigned as student assistants, two to the department of anatomy and two to the department of physiology, and that they shall render such services to the said department as may be assigned them by their respective heads."

This does not mean original work, but it does point to a method of making men better acquainted with the laboratory and giving them a chance to learn their own fitness for such work.

It is also evident that only a very limited number of carefully selected men should be allowed to do research work and that such work should be permitted to count for the degree. There is a practical unanimity of opinion that no man should be allowed to slight his regular work for research, and since he is working for a degree he should have quite as great a responsibility toward his research if he is given the privilege of entering upon it.

The amount of time which different schools give is varied, so varied that no estimation can be made of what is fair. It is obvious, too, that mere numbers of hours mean little, since a small number of consecutive hours may easily be of more use than a large number hopelessly scattered, which never permit more than the hurried starting of experiments and bring no satis-

faction either to the student or his professor.

Finally the belief may be emphasized that experience in actual investigation must be of immense benefit to the student who wishes to approach medicine in the scientific spirit which the times demand. The use of sphygmographic tracings, blood-pressure determinations, and quantitative chemical analyses as every-day aids in the elucidation of a diagnosis requires a mind trained to think in such terms. This is the reason the student turns to the laboratory. He wishes to find out how problems of investigation are approached in order that he may make successful problems of his cases. If, as Dr. Howell believes, "the group of serious workers in medical science will be recruited from this body of students," from the men who, in the words of Dr. Wells, will approach each case "in the same spirit that a laboratory man approaches his problems"—then surely it is worth while to make room in the curriculum for their growth.

Cecil K. Drinker
University of Pennsylvania

SCIENTIFIC NOTES AND NEWS

The council of the Royal Society has made awards as follows: A Royal medal to Professor William Mitchinson Hicks, F.R.S., for his researches in mathematical physics and investigations on the theory of spectroscopy. A Royal medal to Professor Grafton Elliot Smith, F.R.S., for his researches on the comparative anatomy of the brain. The Copley medal to Professor Felix Klein, of Göttingen, For.Mem.R.S., for his researches in mathematics. The Rumford medal to Professor Heike Kamerlingh Onnes, of Leyden, for his researches at low temperatures. The Davy medal to Professor Otto Wallach, of Göttingen, for his researches on the chemistry of the essential oils and the cyclo-olefines. The Darwin medal to Dr. Francis Darwin, F.R.S., for his work in conjunction with Charles Darwin, and for his researches in vegetable physiology. The Buchanan medal to Colonel William C. Gorgas, of the United States Army, for his sanitary administration of the works of the Panama Canal. The Hughes medal to Mr. William Duddell, F.R.S., for his investigations in technical electricity.

The council of the Royal Society has made nominations for the year 1913 as follows: *President,* Sir Archibald Geikie; *Treasurer,* Sir Alfred B. Kempe; *Secretaries,* Sir John Bradford, Professor A. Schuster; *Foreign Secretary,* Dr. D. H. Scott; *Other Members of the Council,* Lieut.-Col. A. W. Alcock, Mr. A. J. Balfour, Sir William Crookes, Dr. F. W. Dyson, Professor W. Gowland, Sir Joseph Larmor, Professor E. W. MacBride, Mr. W. B. Hardy, Professor Micaiah J. M. Hill, Sir Ronald Ross, Professor G. Elliot Smith, Professor A. Smithells, Dr. J. J. Harris Teall, Professor Silvanus P. Thompson, Sir J. J. Thomson and Sir Philip Watts.

Captain Roald Amundsen, who lectured before the Scottish Geographical Society on November 21, was given the Livingstone Gold Medal of the society.

Professor G. A. Miller, of the University of Illinois, was elected a corresponding member of the Spanish Mathematical Society at its general meeting, held at Madrid, April 26, 1912. The only other corresponding member of this society is M. H. Brocard, of Bar-le-Duc, France.

The governing body of Magdalene College, Cambridge, has awarded a research studentship to Mr. E. Hindle, B.A., Beit fellow, who has been working at pathogenic protozoa in the laboratory of Professor Nuttall.

The annual public address of the Entomological Society of America will be given at the Cleveland meeting of the society on Wednesday evening, January 1, at 8:00 P.M., by Dr. Philip P. Calvert, of the University of Pennsylvania. His subject will be "An Entomologist in Costa Rica." He will give an account of a year spent in this entomologically

very rich country, primarily for the study of the seasonal distribution, life-history and habits of Odonata, but including references to other groups of insects, characteristics of various collecting grounds and topics of general interest.

MR. NEWTON D. BAKER, mayor of the city of Cleveland, will give a series of public addresses on four successive Sunday evenings, at 8:00 o'clock, in the Amasa Stone Memorial Chapel of Western Reserve University. The dates and subjects are as follows:

November 24—"The City's Housekeeping."
December 1—"The City's Safety."
December 8—"The City's Health."
December 15—"The City's Ideals."

This series of lectures is a part of the university's program of coordination with municipal and other public interests.

THE College of Engineering of the Ohio State University will offer a course of nine lectures this winter. Prominent engineers and business men will be among the speakers. The purpose of the course is to broaden the acquaintance of the engineering students in the general field of engineering. On January 24, Mr. C. E. Skinner, M.E., of the Westinghouse Company, will lecture on "Research in its Relation to Manufacturing Problems."

PROFESSOR C. E. A. WINSLOW, of the College of the City of New York, lectured on November 21, before the Columbia Chapter of the society of Sigma Xi, on "Some Newer Aspects of the Public Health Campaign."

IN a recent address before the Minnesota Pathological Society, Professor Ludwig Hektoen, head of the department of pathology and bacteriology in the University of Chicago, discussed the epidemics traceable to contamination of milk with streptococci, particularly the epidemic of sore throat in Chicago last winter which involved not less than 10,000 cases and was traced to contamination of a definite milk supply.

AT the meeting of the College of Physicians, Philadelphia, on November 6, portraits of the late John H. Musser, Isaac Hays and Wharton Sinkler were presented to the college, the addresses being made by Drs. George A. Piersol, George E. DeSchweinitz and James C. Wilson, respectively.

DR. ARTHUR TRACY CABOT, the distinguished Boston surgeon, a fellow of the corporation of Harvard University, has died at the age of sixty-two years.

THE death is announced, at the age of ninety years, of M. Aimé Pagnoul, a correspondent of the Paris Academy of Sciences in the section of rural economy.

A COMMITTEE consisting of Drs. Clarence John Blake, John Warren and Frederic T. Lewis, appointed to prepare a memorial to Dr. Leonard Worcester Williams, has presented the following report:

Dr. Leonard Worcester Williams, instructor in comparative anatomy, died in the thirty-eighth year of his age, while absorbed in his work at the Harvard Medical School. Dr. Williams was a naturalist by instinct and education, and took great delight in examining marine creatures of all sorts. In this way he acquired rare technical skill in dissection and broad knowledge of the structure of animals. In 1907 he joined the department of comparative anatomy, and became at once a welcome and most valuable member of the staff. Exquisite preparations remain as permanent mementos of his industry, and his publications are those of an earnest student, careful, painstaking and exact. Of Dr. Williams's personal traits none was more generally recognized than his obliging readiness to help others. During the recent Otological Congress he left his work at the Biological Laboratory in Woods Hole to arrange and direct the display of microscopic specimens. For two weeks in mid-summer his time was at the disposal of the congress, in one form or another of helpfulness. In recognition of such loyal service, freely rendered throughout the five years that Dr. Williams was our associate, we record our high appreciation of his labor in our behalf, and our deep sense of loss in his death.

IN connection with Mr. Andrew Carnegie's offer to provide pensions for future ex-presidents of the United States and their widows —chiefly interesting to university men for the

light it throws on his provision of pensions for professors—it is announced that Mr. Carnegie has transferred $125,000,000 to the Carnegie Corporation of New York incorporated under the act of the legislature introduced on March 22 last year. This corporation has eight trustees, five of whom are the heads of the five institutions which Mr. Carnegie has founded—the Carnegie Endowment for International Peace, the Carnegie Foundation for the Advancement of Teaching, the Carnegie Institution of Washington, the Carnegie Hero Fund, and the Carnegie Institute of Pittsburgh. The heads of these are Senator Elihu Root, Dr. Henry S. Pritchett, Dr. Robert S. Woodward, Mr. Charles L. Taylor and Dr. William N. Frew. The other three trustees are Mr. Carnegie, Mr. Robert A. Franks, president of the Home Trust Company, and Mr. James Bertram, Mr. Carnegie's secretary. By the act of the legislature the incorporators were authorized "to receive and maintain a fund and apply the income to promote the advancement and diffusion of knowledge among the people of the United States by aiding technical schools, institutions of higher learning, libraries, scientific research, hero funds, useful publications, and by such other agencies and means as shall from time to time be found appropriate."

After the annual meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching last week it was announced that forty-eight pensions and retirement allowances had been granted during the year, making a total of three hundred and ninety-eight now in force at an annual expenditure of $570,000. Dr. William F. Slocum, president of Colorado College, was elected to the vice-chairmanship of the board to fill the place of Dr. David Starr Jordan, resigned. Endowments of the Foundation now amount to $14,000,000, Mr. Carnegie having added $2,000,000 since the meeting of the trustees a year ago. The foundation was created with a fund of $10,000,000 and a promise of $5,000,000 more from Mr. Carnegie when it was needed for the state universities. The gift announced last week makes three of the additional five million; during the first years of the foundation's existence it saved $1,000,000 of its income.

The U. S. Civil Service Commission announces a competitive examination for inorganic chemist, for men only, on December 4 to fill vacancies in this position in the Bureau of Insular Affairs, Philippine Service, at salaries ranging from $1,400 to $2,000 a year.

The Illinois Civil Service Commission expects to hold an examination in Chicago on December 14, 1912, to furnish an eligible list for the position of curator of the State Museum. Applicants are not restricted to residence in Illinois but the law requires that they must be geologists and over twenty-five years of age. The present salary is $250 per month. The examination will cover the training and experience of the applicant and in addition will include questions on geology and natural science, museum organization and administration and methods of collection and exhibition of specimens in large museums. A portion of the examination will be oral. This is the first time that such an examination has ever been held for scientific positions in the state service of Illinois.

The committee in charge of the Sarah Berliner Research Fellowship for Women offers annually a fellowship of the value of one thousand dollars, available for study and research in physics, chemistry or biology, in either America or Europe. This fellowship is open to women holding the degree of doctor of philosophy, or to those similarly equipped for the work of further research. Applications for this fellowship must be in the hands of the chairman of the committee, Mrs. Christine Ladd Franklin, 527 Cathedral Parkway, New York, by the first of January of each year.

Section F of the American Association for the Advancement of Science will hold one session at Cleveland for the address of Vice-president Nachtrieb. All papers will be re-

ferred to the program committee of the American Society of Zoologists, and will be read by title only if there is not time for presentation at the announced meetings of that society. Titles and abstracts should be sent to Professor W. C. Curtis, Columbia, Mo., before December 1.

THE fourth annual meeting of the American Phytopathological Society will be held in conjunction with the American Association for the Advancement of Science, at Cleveland, Ohio, December 31, 1912, to January 3, 1913. Titles of papers should reach the secretary not later than December 10 to insure their appearance in the society's program. Papers should not require more than ten to fifteen minutes, and in no case exceed twenty minutes, for presentation. Abstracts not exceeding 200 words, and preferably 100, of all papers to be presented should be submitted with the titles, if possible. In order to appear in the official report of the meeting, all abstracts must be in the secretary's hands at the close of the meeting. The pathological exhibition, which was such an interesting and successful feature of the Washington meeting, will be continued at Cleveland. Correspondence in regard to exhibits and space should be addressed to Professor A. D. Selby, Wooster, Ohio. Facilities will be provided for displaying exhibits of all kinds.

THE Ohio Academy of Science will hold its annual session at the Ohio State University, November 28–30. The program contains fifty papers. The academy will decide the question of establishing a series of publications which shall include the results of the work done for the Biological Survey of Ohio, which was recently established by the Ohio State University. Several of the colleges of the state are cooperating with the university in making the survey.

THE New York State Science Teachers Association will hold its annual meeting in the Central High School, Syracuse, N. Y., on December 26–28, 1912. The sections are: (*a*) Physics and Chemistry, (*b*) Biology and Nature Study, (*c*) Home Economics.

THE International Union for Solar Research will meet at Bonn beginning August 1, 1913.

A SOCIETY for the study of medical history has been established in London as a section of the Royal Society of Medicine. The first meeting was held on November 20.

THE fourth Congress of Physiotherapy will be held at Berlin, March 26–30, 1913, under the presidency of Professor His. The principal subject proposed for discussion is the treatment of disturbances of the circulation. The work of the congress will be divided among four sections: (1) hydrotherapy, balneology, seaside and climatic treatment; (2) electro-therapy and radium-therapy; (3) orthopedics, movement treatment and massage; (4) dietetics. There will be an exhibition in connection with the congress.

THE tenth International Congress of Agriculture will be held at Ghent next year. The Belgian government and the provincial councils as well as the municipal authorities of Ghent have promised their support to this congress. The various foreign governments have been asked to send delegates. The opportunity of visiting the agricultural exhibition, or "The Modern Village" as it will be called, and the numerous excursions which will be arranged, will make the congress one of special interest. County councils, agricultural societies and colleges, professors of agriculture, farmers, market gardeners and agriculturists generally in all parts of the world are invited to become members of the congress. The reports and proceedings, to be issued in six volumes, will form an agricultural encyclopedia of all subjects of current interest. The congress will meet from the eighth to the thirteenth of June inclusive. Applications for membership, enclosing a money order for 20 francs, should be sent to M. Inspector Vandervaeren, 228, chaussée d'Alsemberg, Brussels. The American committee, so far formed, consists of the follow-

ing: Dr. L. O. Howard, member of the International Commission on Agriculture and chief, Bureau of Entomology; Dr. A. C. True, director, Office of Experiment Stations; Mr. John Hamilton, specialist in farmers' institutes, Office of Experiment Stations; Dr. C. F. Langworthy, chief, nutrition investigation, Office of Experiment Stations; Dr. J. I. Schulte, assistant agriculturist, Office of Experiment Stations.

The last Congress made appropriations for the U. S. Geological Survey for the fiscal year ending June 30, 1913, as follows:

Topographic surveys	$350,000
Geologic surveys	300,000
Mineral resources of Alaska	90,000
Mineral resources of the United States	75,000
Chemical and physical researches	40,000
Geological maps of the United States	110,000
Gaging streams, etc.	150,000
Surveying national forests	75,000

The bill also appropriates $145,000 for printing and binding survey reports, to be expended by the public printer.

The will of the late Catherine E. Beecher, in compliance with the wishes of her husband, bequeaths her estate for the endowment of a department in the Academy of Natural Sciences of Philadelphia to be known as the J. F. Beecher Biological and Anthropological Laboratory. The bequest, with the conditions defined in the will, has been accepted by the academy. The estate is to be kept intact for ten years before the income is available for the designated purpose.

Among the geological and mineralogical collections of the United States National Museum is an odd boulder of solid copper, known as the Ontonagon Boulder, which has a very interesting history. This large mass of copper has been in the possession of the Smithsonian Institution since 1860, and has recently been moved to the new museum building, where it is now on exhibition in the southeast corner of the east hall on the second floor. The boulder has the appearance of a dull bronze-colored rock, much chipped and worn. It is 3½ feet long, 3 feet wide and 1½ feet in its thickest part, and owing to the great density of copper, weighs nearly 3 tons, a large weight for such a relative small bulk. For ages this remarkable mass of copper lay on the west bank of the Ontonagon River in the upper peninsula of Michigan, where it was known for many years by the Chippewa Indians of that region. It was not until 1766, however, that the first white man, Alexander Henry, an English adventurer and trader, visited this remarkable specimen. During the next 75 years many explorers and scientists followed Henry's footsteps until the boulder became well known as a mineralogical curiosity. It was undoubtedly a valuable specimen worth several thousands of dollars, but its weight prevented any one from making away with it. In 1841, Julius Eldred, a hardware merchant of Detroit purchased this copper rock from the Chippewa Indians on whose lands it was located, and two years later, after many difficulties, succeeded in transporting it down the Ontonagon River, through Lake Superior to Sault Ste. Marie, and thence to Detroit, where it was placed on exhibition for a brief period. Soon after its arrival, the government claimed it, and towards the end of 1843 it was shipped to Washington and deposited in the yard of the Quartermaster's Bureau of the War Department, where it remained until 1860, when it was transferred to the Smithsonian Institution. Some years later the government repaid Mr. Eldred for his time and energy in securing this boulder, congress having appropriated the sum of $5,664.90 for his relief. This specimen represents the first considerable quantity of copper from the Lake Superior region, a district which has since become one of the important copper-producing regions of the world. It undoubtedly came out of the adjacent copper-bearing rocks, and was probably transported southward a short distance during the Glacial Period in the Glacial drift which now covers that country. The museum specimen, though large and interesting, is not by any means the largest solid piece of copper ever found. Copper masses of immense size are encountered from time to

time in the mines of Lake Superior, and the largest recorded was found in 1857 in the Minnesota mine. It measured 45 feet in length, 22 feet at its greatest width and more than 8 feet at its thickest part, and contained over 90 per cent. pure copper. The total weight was about 420 tons.

THE *Observatory* gives the following from the *Daily Chronicle,* a leading London paper:

Actors and others are discussing what they shall do with the seventh day. There is a tiny island in the South Pacific where there is no seventh day, six days being the allotted span of every week. All travelers know that time is lost or gained in traveling east or west, and Chatham Island is just on the line of demarcation between times and dates. To keep in line with the almanac, therefore, the plan has been adopted of jumping the afternoon of one day and the morning of the next in every week, so that the islanders commence Wednesday, but at 10 o'clock switch on to Thursday afternoon.

UNIVERSITY AND EDUCATIONAL NEWS

THE children of the late James Dwight Dana (Silliman professor of geology at Yale University from 1850 to 1895) have offered to establish a fund which shall ultimately reach $24,000, the income to be used "to further study and research in geology."

BY the will of Frederick Blanchard of Tyngsboro, Harvard University receives for the use of the Museum of Comparative Zoology his entomological collection.

MRS. JOHN JOSEPH ALBRIGHT, of Buffalo, a trustee of Smith College, has given $60,000 toward the million-dollar fund. This gift is to establish what will be known as the S. Clarke Seelye professorship. The subscriptions now amount to about $500,000.

THE corporation of Yale University has passed a statute regarding sabbatical years, making it possible for a professor or assistant professor to take a half-year's absence on full salary as an alternative for a full year at half salary. A similar plan was adopted by the trustees of Columbia University several years ago.

ENROLLMENT figures for 1912–13 for all departments of Western Reserve University are announced this week at the university as follows: Adelbert College, 456; the College for Women, 354; the Graduate School (incomplete), 14; the Medical Department, 168; the Law School, 130; the Dental School, 127; the Library School (incomplete), 50, and the School of Pharmacy, 111. The total enrollment for all departments is 1,410. Western Reserve University, in its undergraduate departments, Adelbert College and the College for Women, has decided that, under ordinary conditions, no division of a class for recitation purposes is to exceed twenty-five persons. This vote, applying to all classes, means that in the freshman class of Adelbert College there will be seven divisions, and in the freshman class of the College for Women five divisions in all required subjects. Many large elective classes will be divided into two, three or four divisions.

DR. FRANK PELL UNDERHILL, assistant professor of physiological chemistry in the Sheffield Scientific School, Yale University, has been elected professor of pathological chemistry in the Medical School.

PROFESSOR R. C. PUNNETT has been appointed the first Arthur Balfour professor of genetics at Cambridge University.

DISCUSSION AND CORRESPONDENCE

RADIOTELEGRAPHIC ACHIEVEMENTS BY THE POULSEN SYSTEM

TO THE EDITOR OF SCIENCE: I wish to call attention to the important results being accomplished in this country by the Poulsen system of wireless telegraphy. This system and the work that is being done by it is of great scientific interest as well as practical importance, and inasmuch as almost nothing is generally known about it a brief account of its main features may be of interest to the readers of SCIENCE. Although not a physicist I am led to call attention to this subject because I have waited in vain to see any mention of it in scientific journals, and because numerous students of related subjects whom I know

have failed to take much interest in it. This lack of interest is apparently due to the prevailing prejudice against the claims of wireless telegraph companies in general.

The system of wireless communication in question is that invented by the Danish scientist Valdemar Poulsen, and is radically different from the Marconi and related spark systems. Instead of intermittent waves such as are sent out by the spark system, the Poulsen system sends undamped continuous waves by means of an arc. In transmitting a message the signals are given not by interrupting the current but by slightly varying the wave-lengths in a continuous wave train. Experience is proving that such continuous wave trains are far less affected by adverse atmospheric conditions and other obstacles, and are propagated long distances with much less power than the broken waves sent out by the spark system, and that they possess numerous other advantages. As a result, entirely reliable communication for long distances over land, and communication by day almost as well as by night, is made possible.

The greatest advances in the development of this system are being made in the western part of the United States, largely by persons now or heretofore connected with Stanford University. Stations ranging in power from 5 to 30 kilowatts are in operation in the large cities on the Pacific Coast, from Seattle to San Diego, and at Phœnix, El Paso, Fort Worth, Kansas City and Chicago. Telegraphic messages are being transmitted constantly, day and night, along the Pacific Coast and as far east as El Paso, and messages are sent from there by night to and from the comparatively low-power stations so far installed at Fort Worth, Kansas City and Chicago. Since the recent establishment of a 30-kilowatt station at San Francisco with two 440-foot towers it has been found possible to send messages direct from the coast to Fort Worth and Kansas City, and do away with the intermediate relays. Within the past few weeks a station has been completed at Honolulu and every day from 1,000 to 4,000 words of news and private messages are sent thither by the San Francisco station. This news appears in the Honolulu daily paper and, by virtue of its cheaper cost than news by cable, is affording the people there for the first time complete news of the world each day. This distance is more than 2,350 miles and is the longest over which continuously successful wireless communication has ever been established. Furthermore it is the longest single span of ocean necessary to cross in circling the globe, and forecasts trans-Pacific wireless communication in the near future. The power used at these Pacific coast stations is only a small fraction of that necessary for sending messages by the spark system across the two thousand miles of ocean from Ireland to Nova Scotia.

With the aid of mechanical transmitters and receivers from 100 to 300 words per minute are accurately sent and received by the Poulsen system over distances of several hundred miles, and a method has been devised whereby two messages can be sent or two received simultaneously over the same antenna. The wave-lengths can be readily varied, and, as each station has its assigned wave-length to which it keeps its receiving apparatus attuned, messages can be sent to any point desired without troubling other stations. Or, if desired, all stations within range can receive the same message simultaneously. Messages sent by the Poulsen system are not read by operators of other systems and the stations do not experience the interference from outside operators which is so troublesome a feature of the spark stations.

In addition to telegraphic communication the Poulsen system has been proved successful for wireless telephony. I can personally attest the simplicity and clearness of this method of transmitting speech, having telephoned more than two years ago between Stockton and San Francisco, a distance of 80 miles over land. Subsequently speech has been carried in this way from San Francisco to Los Angeles, 450 miles, but as yet no thorough tests have been made of the system's telephonic possibilities, attention having been concentrated upon the telegraph.

There are other novel and important features of the Poulsen system which it would take too long to mention. As yet only a beginning has been made in developing its possibilities. The next step will be to test and put in use generators of increasing powers, from which increasing ranges are expected. The success so far attained has advanced the science of communication considerably beyond its generally recognized limits, and affords sound basis for the expectation that a few years will see much of the present work not only of ocean cables but also of long distance telegraph lines done by undamped electromagnetic waves transmitted through space.

ROBERT ANDERSON

WASHINGTON, D. C.,
November 6, 1912

PICTURES OF PSYCHOLOGISTS

HAVING the Open Court series pictures of psychologists and philosophers, I have often wished that I had those of present-day psychologists on the walls of my recitation room. I have often thought of writing to psychologists for their photographs, but that would be a good deal of trouble and if a number followed that plan it would become a nuisance to those whose pictures were most desired. A continuation of the Open Court series would be desirable, but who is to decide which of the living men should be included and would not such a series be unprofitable because of its inclusions and omissions?

The following plan occurs to me as a means of getting what is desired without any of the above disadvantages. Let those desiring photographs name the ones whose pictures are desired to the one who is willing to take charge of the matter. That one can then procure one photograph of each person named and have a plate made from it of the same size as the Open Court series and arrange with a photographer to furnish photos from these plates at a reasonable rate.

Are there enough who desire such pictures to make it worth while to inaugurate the plan? This can be answered if all who are interested will at once write to me signifying their desires and naming at least a few of the men whose pictures they wish. Prominent educators and perhaps other men of science might be included if they were asked for. If interested do not fail to write at once.

E. A. KIRKPATRICK

FITCHBURG, MASS.

SCIENTIFIC BOOKS

The Spider Book. A Manual for the Study of the Spiders and Their Near Relatives, The Scorpions, Pseudoscorpions, Whip-scorpions, Harvestmen, and Other Members of the Class Arachnida, Found in America north of Mexico, with Analytical Keys for Their Classification and Popular Accounts of Their Habits. By J. H. COMSTOCK. Garden City, New York, Doubleday, Page & Co. 1912. Pp. xv + 707; 771 figs.

This work, the most recent of the series of well-known nature books published by Doubleday, Page & Company, fills a long-felt need, since the spiders are the most abundant and conspicuous representatives of a large group of organisms, which have never aroused an interest, in the American student at least, at all commensurate with their biological and economic importance. The author has arranged the vast amount of material, which he has accumulated during more than a decade of enthusiastic study, in conformity with the plan adopted in the preceding volumes of the series, throwing the emphasis on the classification and subordinating the morphological, ethnological and chorological data to this arrangement. By way of introduction to the main subject of the volume the various lower groups of Arachnida are briefly discussed. This portion of the work, apart from the useful tables for identification, does not rise above the level of many zoological text-books, and some of the sections, as, *e. g.*, those on the ticks and mites, scarcely do justice to our present knowledge or to the economic importance of the subject. The account of the spiders, which are, after all, *the* subject of the book, is preceded by chapters on

their external and internal anatomy and their behavior. The anatomical treatment is detailed and comprehensive but, except for a careful description of the male palpus, contains little that is new. Professor Comstock's study of the palpus forms a small treatise in itself and constitutes a valuable contribution to our knowledge of a peculiarly intricate mechanism. The spinning glands are also discussed in considerable detail as the author has been much interested in the construction of the web, a subject fully treated in his account of the "life of spiders," to the neglect or abridgment of many other equally interesting habits in these solitary organisms. No general account of the geographical distribution of the nearctic species is attempted, although such an account would have been very timely and of great interest to many zoologists who are not arachnologists. The systematic descriptions of the genera and species, and especially the tables for their identification, which occupy three fourths of the volume, are extremely valuable. The species are adequately illustrated from photographs or drawings of living or recently killed specimens, with their webs, nests, details of anatomical structure, color patterns, etc. Most of the figures have been well reproduced, but in some cases the fine photographs have suffered the customary deterioration in the hands of the engraver and printer. These are, of course, not the faults of the author, who deserves the hearty congratulations and thanks of all American zoologists for having given them such a helpful and beautiful volume.

W. M. Wheeler

Duc d'Orléans. Campagne Arctique de 1907. Annélides Polychètes par Pierre Fauvel, iv, 45 pp., 4°, 2 pl.; Crustacés Malacostracés, par le Dr. Louis Stappers, xxiv, 152 pp., 4°, 7 pl., 2 charts. Imp. Sci. Bruxelles, 1911.

The annelid fauna of the Arctic seas being practically circumpolar, and investigated in much detail by the Scandinavian and German naturalists, it was hardly to be expected that the expedition of the Duke of Orleans on the *Belgica* in 1907 would add many novelties. As a matter of fact *Sphærodorum philippi* Fauvel was the only new species among the sixty-two collected on the coasts of Novaia Zemlaia, the Murman, Kara and Polar seas. Valuable notes as to the distribution, and data on the organization of several little-known forms, and a useful bibliography of work on Arctic annelids ensure a welcome for the memoir.

The sea north of Siberia has been but partially explored for Crustacea, and Dr. Stapper's collection, in spite of the adverse circumstances attending work in ice-encumbered waters, comprised no less than ninety-four species, of which two amphipods, one isopod and two sympods proved unknown to science.

Many of the species collected were obtained in considerable numbers, which permitted dissection of numerous individuals. The exact data as to distribution in depth and geographic range render the records of the collection especially valuable to science, and the twelve pages of bibliography will prove a boon to students. The execution of the plates as usual with this series of reports leaves nothing to be desired.

Wm. H. Dall

Beyond War: A Chapter in the Natural History of Man. By Vernon L. Kellogg. New York, Henry Holt and Company. 1912. Pp. ix + 172. $1.00.

A biologist's contribution to the literature of the peace movement. The argument of the book runs somewhat as follows. "Man" is, like any organic species, a stage in evolution, an organism with a past and with a future. Human nature, like Nature herself, is not immutable, but inevitably mutable. Characteristics possessed at one time by the supra-modal few come to be possessed by the mode, and in passing are represented, for a time, only in the sub-modal group. War is such a trait—now vestigial, not rudimentary—an anomaly and an anachronism; it will disappear from human life when the mode of the species is well beyond war. When the

facts of man's whole history are brought into line, one can, sighting along it, see that his evolution is clearly to be away from war. Like an organic species, war is a species of conflict and it will give place to other forms of conflict, no less real but more humane.

To many scientific readers the most valuable part of this book will prove to be the convenient summary of man's physical and mental evolution during quaternary times, contained in Chapters II–V. Here are presented, in Professor Kellogg's well-known, striking style, and in a form well adapted for the general reader. the evidence for the existence of Tertiary man, and brief characterizations of early Quaternary man—"Homo Primigenius: Man of the Great Ice"—who found in fighting his chief occupation and diversion. "Homo Priscus: Man after the Ice," partially freed by his wit from constant struggle with the rest of nature, devotes some of his newly acquired leisure toward fashioning his own environment.

Neolithic man, "Homo Sapiens: Man of History," gets something to call "culture." He begins to experience the results of his own modification of his environment, and finds that he has inherited not only instincts and reflexes, but also the capacity to modify these by the exercise of reason; and so he begins to take a hand in directing the evolution of his "human nature." Kellogg recognizes the proximity of this idea to the "inheritance of acquired characters," but proceeds. Man of to-day, as an individual, fights as a pastime chiefly, and international war has become primarily a struggle to destroy dollars. The real desire for war occasionally is said to be already a sub-modal species character.

As to Quinternary man, "Homo Superioris: Man of To-morrow," Kellogg ventures to prophesy, saying that his physical constitution seems fixed and unlikely to be much further changed, and he must perforce depend for his existence upon the evolution and use of his intelligence. As this develops man will recognize the truth about war and will, must, eliminate it from the species life.

It is obviously possible to arrange the leading facts of man's evolutionary history so as to indicate the future elimination of war, and, faith being the substance of things hoped for, let us have faith that this prediction may be speedily fulfilled. But that one may also arrange the facts of man's whole history, as well as of man's History, so as to point in any direction hoped for, is still true; and many of Kellogg's theses might serve as subjects for argumentation.

"Beyond War" is a clear indication of the now recognized necessity of enlarging history to include the whole history of man and his works, and of the important relation of biological facts to the work, not only of the historian, but of the politician, the economist, sociologist, philanthropist and peacemaker. While our biological substructure may not yet be able really to bear the load often thus placed upon it, we should and do welcome heartily every attempt of the trained biologist to make his science available for use and for human life.

WM. E. KELLICOTT

BOTANICAL NOTES

THE BRUSSELS CODE

IT may now be well in the middle of the lustrum between the Brussels Botanical Congress (of 1910) and the London Congress (to be held 1915) to make some pronouncements upon what progress has been made towards securing a useful and workable code and what remains yet to be done. Before the Vienna Congress (in 1905) there was great diversity of practise among botanists, and not a little heat and temper had been displayed by the champions of this or that particular view. When Otto Kuntze about twenty years ago stirred up the whole subject there were many who regarded his action as wholly unnecessary and uncalled for, and yet it is true that from this stirring up of things have come the two congresses, namely, at Vienna, and Brussels, and much that Kuntze contended for has now been enacted into botanical law. So too, the movement in America a little later,

culminating in one or two published "codes," served to accentuate the demand for a more general agreement as to what should be good botanical practise.

Most botanists have had in hand for about three months Briquet's report and compilation of the code as modified by the Brussels congress, and they have had time to consider the wisdom of the more recent changes and additions, and the adequateness of the code as a whole. In considering this code we must not overlook the fact that we have secured the recognition of our chief contention, namely, the "law of priority." So too we have secured the recognition of the necessity for a *beginning date* for nomenclature. And today the original name of the species is preferably retained, whatever generic wanderings it may suffer, and a name which has become a synonym can not be used for another plant. Even in regard to publication and the use of parentheses the essentials that we contended for have been enacted into law. Only in regard to the use of specific names which repeat the generic name does the new code run counter to the practise of many American botanists, and it must be said for this latter point that few of us would care to insist strenuously upon the acceptance of our practise.

So we have succeeded in having most of what we demanded included in the botanical code, but as always happens when legislation is had, some things have been added that are not at all to our liking. Thus with the underlying principles (Arts. 1 to 18) no fault need be found, but in our opinion the Brussels congress made a series of blunders in Art. 19, when it selected the starting points for the nomenclature of various groups. In fact here there was evidently a hopeless confusion of "starting points" with complete monographs, resulting in the designation of not less than twenty different dates, in eight publications, with at least four more groups still to be heard from. When it is suggested that the point of beginning for some algæ is 1753 (Linne's "Sp. Plant."), while for others it is any place from 1891 to 1893, and for still others 1886, and for others again 1848, while for one little family (*Oedogoniaceae*) it is as late as 1900, it is pretty evident that the law makers forgot what they were doing. This matter of starting points for nomenclature will have to be revised by men who can "keep their heads"!

Then while the law of priority is sanctioned (Art. 15) the vicious practise is enlarged of making exceptions (*nomina conservanda*) of names that are to be retained in spite of the law. Such "special legislation" reminds us of what political legislatures sometimes do when exceptions are made in favor of "special interests," but certainly such things ought not to be done by a body of scientific men. The Brussels Congress augmented the lists of *nomina conservanda,* and in doing so showed more forcibly than at Vienna that the lists have no scientific basis, but that they rest upon the prejudices and preferences of a few botanists who object to the use of unaccustomed names for certain plants. Prejudice and individual preference have no rightful place in determining scientific nomenclature. One is inclined to quote here the final article (58)—"The rules of botanical nomenclature can only be modified by competent persons at an international congress convened for the express purpose," and to make the very obvious remark that it may be questioned whether all of the work before us was done by "competent persons." In the opinion of the writer this question must be answered in the negative for some parts of the code.

Now, what shall we do in regard to this code? There are those who boldly say that a code so drawn up should not be obeyed, and accordingly they ignore such of the rules as they do not approve. And the temptation to do so is very great, especially in regard to the starting points of nomenclature, and the *nomina conservanda,* but we are convinced that the wiser policy will be to accept the code as a whole, and obey its dicta. Of course it is never an agreeable thing to have to do what our judgment disapproves, but the only way that we can make progress is to submit to the code as it is, with the determination, that we will bring about the desirable revisions and

changes as rapidly as possible. So we conclude that, disagreeable as it may be, it is the best thing for the science that we should obey the rules of the code.

CROWN GALL AND CANCER

ATTENTION should be called again to Dr. E. F. Smith's suggestive paper "The Structure and Development of Crown Gall: A Plant Cancer,"[1] issued June 29, 1912. In its preparation the author was assisted by Nellie A. Brown and Lucia McCulloch, scientific assistants. As expressed by Dr. B. T. Galloway in his letter of transmittal to the Secretary of Agriculture:

> This paper is the result of many months of critical study of hundreds of serial sections prepared on the microtome; and so far as relates to the photographic demonstration of the presence of the causal organism within the proliferating cells, to several years of laborious and discouraging experimentation with a variety of fixing agents and stains. Only recently has it been possible to demonstrate clearly by means of the microscope the presence of the parasitic organism within the cells, although the authors have known for more than five years that this organism *must be* located within the cells.

Proof of the latter contention having been attained the conclusion is reached that

> While it is the rapidly proliferating cancer cells that do the michief they are impelled to behave in this way only because they are under the stimulus of a foreign organism which does not destroy them but irritates them to rapid division.

We can well agree with Dr. Galloway in pronouncing this "a discovery of the first magnitude in pathology."

The paper is accompanied with one hundred and nine "half-tone" reproductions of photographs, often very highly magnified, and these plates constitute the greater part of the evidence upon which the author relies. Among the statements given in the résumé the following may be quoted:

> Crown galls occur on a great variety of plants, but not always on the crown; any part of the root or shoot is liable to attack.

[1] Bull. 255, Bureau of Plant Industry, U. S. Dept. Agric.

Young, well-nourished, rapidly-growing tissues take the disease more readily than old or slow-growing ones.

They are all of parasitic origin, unless the one on the beet studied by Jensen, Reinelt and Spisar, in Europe, should prove an exception.

These galls are due to schizomycetes, either to one polymorphic species, or to several closely related species. Further studies are necessary.

The parasite has been shown to occur not only in the primary tumor, but also in the secondary tumors and in the connecting tumor strand.

The tissues of the gall multiply excessively and in opposition to the best interests of the plant.

The galled tissue, which is often of a soft, fleshy nature, is much subject to decay. It is not usually corked over, and this absence of a protective surface allows the ready entrance of water and of other parasites.

The tumor originates in meristem, usually in the cambium region. It may perish within a few months or continue to grow (parts of it) for years.

The tumor consists, or may consist, not only of parenchyma cells but also of vessels and fibers, *i. e.*, it is provided with a stroma which develops gradually as the tumor grows.

The tumor sends out roots (tumor strands) into the normal tissues. These may extend for some distance from the tumor—how far is not known. These strands consist of meristem capable of originating medullary rays, tracheids and sieve tubes.

The stimulus to tumor development comes from the presence of the parasite within certain of the cells.

The relation between the host and the parasite may be regarded as a symbiosis in which the parasite has the advantage.

The bacterium is a soil organism and planters should aim to keep their lands free from it by refusing to plant infected stock.

The organism is a wound parasite. Its entrance is favored by careless grafting and by the presence of borers, nematodes, etc.

Nothing in this bulletin should be construed as indicating that we think the organism causing crown galls is able also to cause human cancer, but only that we believe the latter due to a cell parasite of some sort, and offer the preceding pages in support of this contention.

CHARLES E. BESSEY
UNIVERSITY OF NEBRASKA

THE ANALYSIS OF NATURAL SELECTION[1]

The actual operation of natural selection is rarely investigated. The various methods that have been employed will be here considered seriatim, in order that their advantages and limitations may be noted.

1. The comparison of the mean magnitude of the characteristic in question in those individuals that died either with that of the survivors or with that of the whole number. This method is simple and where the difference is considerable does provide proof that secular[2] natural selection was operative. Its shortcomings are that it furnishes no analysis of the operation of selection and that periodic[3] natural selection is not detected by it.

2. The index of correlation between the length of time of successful resistance to the adverse condition and the magnitude of the characteristic in question. This method has been used by Dr. F. E. Lutz on *Ampelophila*. In addition to demonstrating the action of natural selection, it may in some cases, as in *Ampelophila*, throw valuable light on the action of the cause of death. Its limitation is its failure both to discriminate between periodic and secular selection and to analyze the distribution of the incidence of natural selection.

3. In addition to comparing the means of the individuals that perished and survived, Bumpus, in his well-known sparrow observation, compared the extremes with the whole number, in this way being able to detect any periodic selection that may have taken place, as well as the secular selection. This method, too, falls short, because a still closer analysis is desirable, and because the result hinges on the particular choice of the percentage of the whole chosen to represent the extreme.

4. We have a further step in analysis in Weldon's method of showing the results of his classic experiment in subjecting *Carcinus* to clay suspended in water. Here the polygon of the perished is superimposed upon the polygon of frequency for the whole number. The eye can then wander along the polygons and observe the relation of the two throughout their courses, which makes a fuller analysis possible. But in making the analysis the mind must compute the ratio for each class as best it can.

The method which I wish to propose determines these ratios precisely and plots them graphically. The survival rate is determined for each class, and plotted, preferably superimposed upon the polygon of frequency of the whole number, so that the numbers used are shown. Since the probable error of the survival rates increases towards the extremes where based upon fewer individuals, some method of combining classes is frequently desirable. Only such combining should be done as is considered absolutely necessary, because the analysis is less discriminative by just so much. The combining may be done by arbitrarily adding the classes in groups of 2, 3, 4, etc., or by combining the most extreme eighth in one direction, the next eighth, and so forth. This may be done absolutely, or in some cases, to the nearest class. The particular method depends largely upon the number employed. Rougher grouping and a larger number of classes are permissible where there are large numbers. In Fig. 1 I have applied the method to Weldon's experiment with crabs (male *Carcinus mœnas*) in muddy water. The survival rate is determined for each class and a survival curve thus established. It will be seen that, even with this large number of classes, the curve is clearly inclined. In Figs. 2 and 3 I have replotted the curve in four and eight classes, respectively, of about equal numbers to smooth out the irregularities arising from the small numbers in the extreme classes. With so active a natural selection, one can well believe that, in spite of the criticism of Cunningham, there actually took place in nature the evolution shown by the statistics gathered in the successive years of the crabs at Plymouth.

[1] This article was written while the author was on the staff of the Station for Experimental Evolution at Cold Spring Harbor, N. Y., of the Carnegie Institution of Washington.

[2] Pearson's term for the form of natural selection which favors one extreme over the other.

[3] Pearson's term for the form of natural selection which favors the mode at the expense of the extremes.

The numbers are smaller in the widely quoted observations of H. C. Bumpus on the sparrows which survived in a lot that were picked up after a severe storm at Providence, R. I. By using only four classes, however, the survival curve is so inclined that we may safely draw conclusions. The conditions in this study probably do not show the full selective effect of the catastrophe, for we here contrast those which perished with the disabled which survived when protected. The sparrows which had succeeded in finding suitable shelter would probably have shown a still greater difference from those that died, could they have been obtained. Bumpus confined himself to a study of the absolute measurements, but since there was a selection as to the size of the birds (Fig. 4) I have reduced the other measurements to percentage of length. The result shows a much greater influence of selection than that shown by the absolute measurements. The selection is also seen to be secular (Fig. 5) rather than periodic, as Bumpus concluded from the absolute measurements. The survival curves are shown for the sake of direct comparison in one diagram, using as ordinates the average of the respective classes.

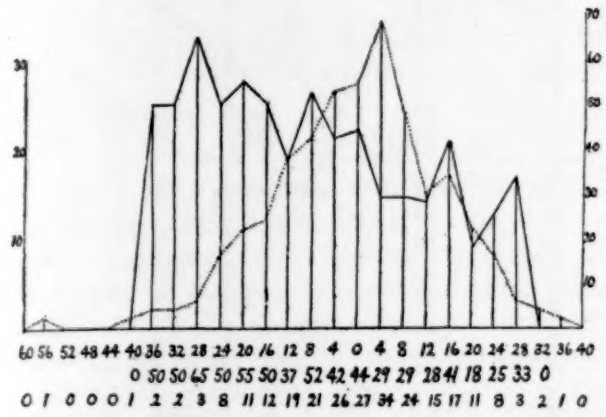

FIG. 1. The polygon of frequency of the frontal breadth (dotted line) of *Carcinus mœnas* in Weldon's experiment, with the survival rate (solid line). First line of numbers, deviation; second line, survival rate; third line, numbers.

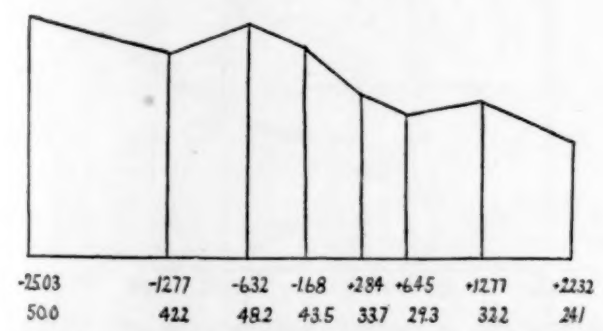

FIG. 2. The survival polygon in the Weldon crab experiment plotted in eight classes. First line of numbers, deviation; second line, survival rate.

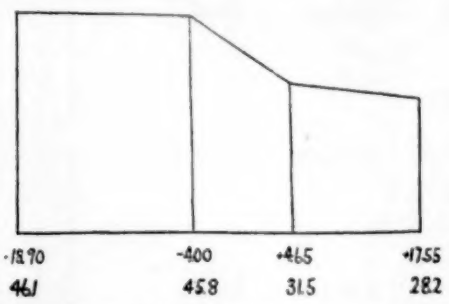

FIG. 3. The survival polygon in the Weldon crab experiment plotted in four classes. First line of numbers, deviation; second line, survival rate.

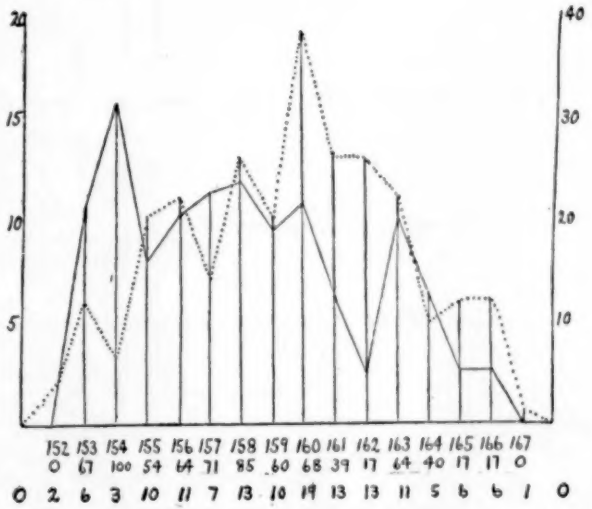

FIG. 4. The polygon of survival rate of the length in the Bumpus sparrow case. First line of numbers, length in millimeters; second line, survival rate; third line, number of individuals.

Curiously enough, while the males show a well-marked secular selection in the same direction in each measurement, the females are either only slightly secular or indifferent. In some cases, like the measurements of the femur and humerus of the males, the differences are very great, all of the longest fourth

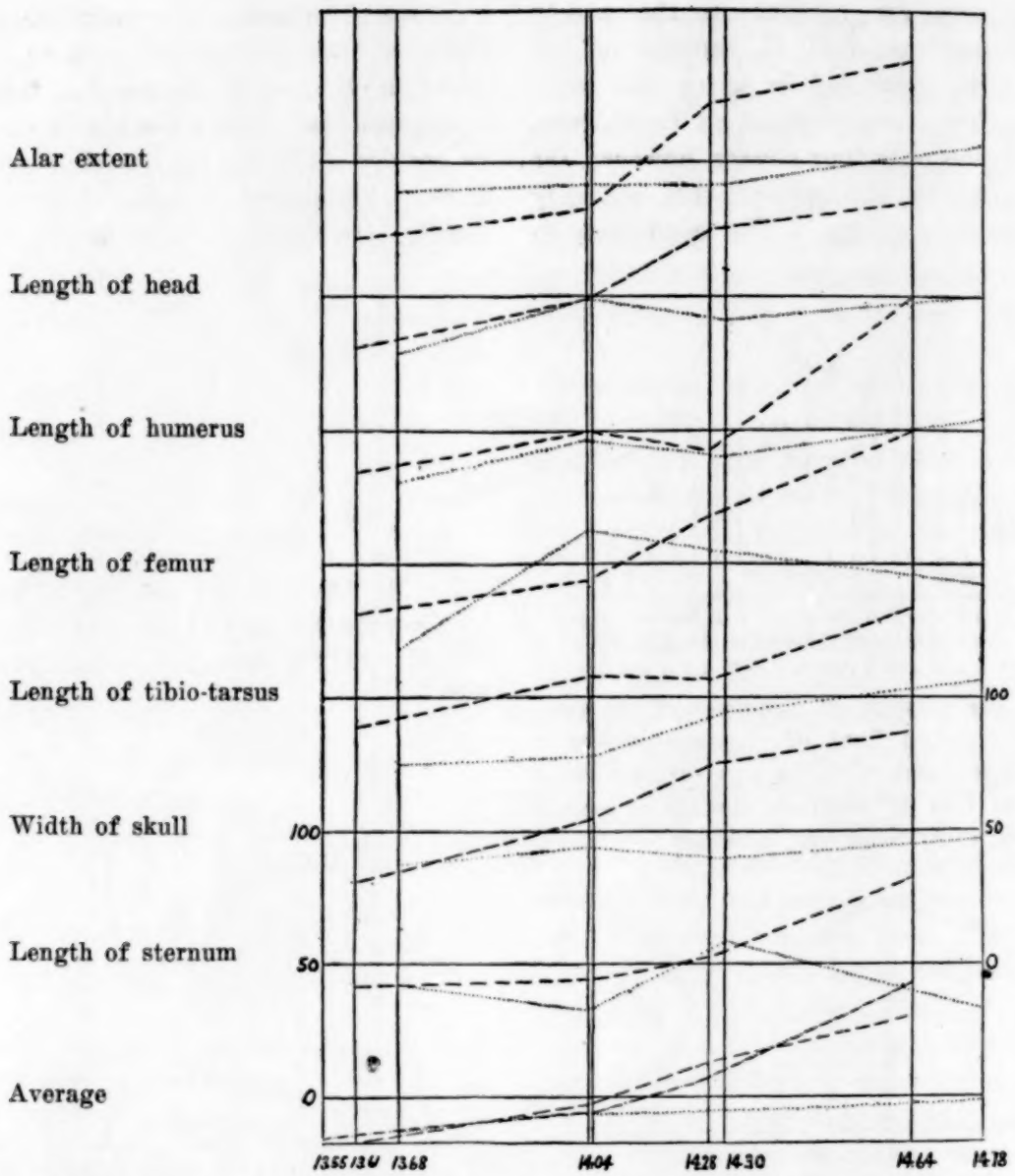

Fig. 5. The survival polygons of the measurements expressed in percentage of length in the Bumpus sparrow case. Dash line, all males; dotted line, females; dot and dash line, young males. The horizontal line opposite the name of each dimension represents 50 per cent. survival, the next horizontal line below 0 and the next above 100. Numbers at bottom are the average dimensions of the four classes.

(divided to the nearest class) surviving. Bumpus had based his conclusions on the very few extreme individuals, instead of the two extreme fourths. I believe this is dangerous, on account of the small numbers, but for comparison, I have also plotted the extreme classes. To avoid the danger of small numbers, I have combined the extremes in all six characteristics, since the survival curves have a common inclination. Here also the result (Fig. 6) shows secular and not periodic selection. Bumpus was led to his conclusion from the fact that in length there is some degree of periodic selection as well as secular selection shown (Fig. 5). Even in length the small numbers involved in the end classes cast some doubt as to their significance. Taken as a whole, therefore, I believe this sparrow catastrophe reveals very much more secular than periodic selection, if there be any of the latter, although very naturally the experiment has been quoted to show periodic selection in the

literature of evolution, where it has figured so largely.

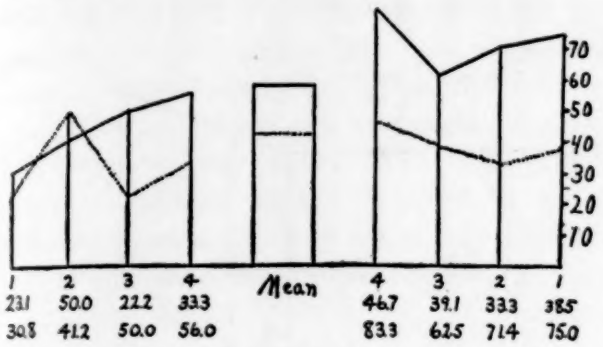

FIG. 6. The survival rate in the extreme cases in the Bumpus sparrow case to test periodic selection. The rates plotted are the rates made up by averaging those for the corresponding extreme classes of all the dimensions, each expressed in percentages of length. First line of numbers, the extreme classes; second line, survival of females; third line, survival of males.

The weight of the sparrows shows a secular selection in a negative direction, but in percentage of length, the selection seems indifferent. The selection in absolute weight, therefore, is due to the correlation with length which is selected. For this reason and because it is not a dimension, I have not plotted it with the other characteristics (Figs. 7 and 8).

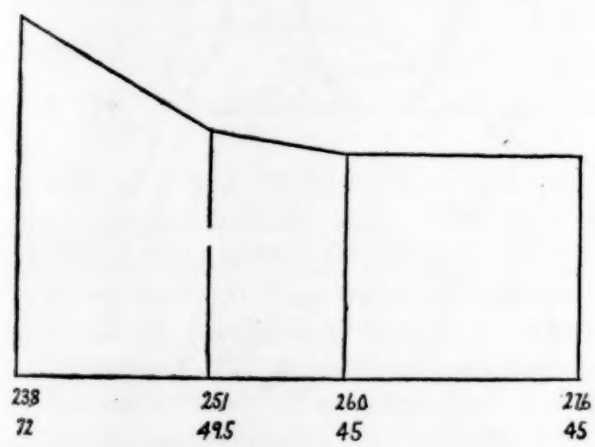

FIG. 7. Survival polygon for weight in the Bumpus sparrow case plotted in four classes. First line of numbers, weight in grams; second line, survival rates.

The application of this method to Crampton's observations on the length of antennæ in female pupæ of the moth *Philosamia cynthia,* is shown in Figs. 9 and 10. This shows clearly the amount of selection and brings out the fact, which is otherwise overlooked, that

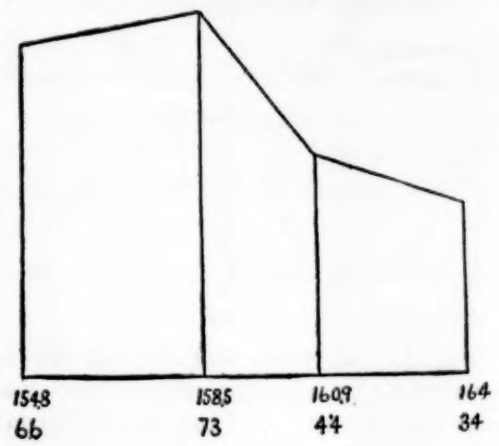

FIG. 8. Survival polygon for length in the Bumpus sparrow case plotted in four classes. First line of numbers, length; second line, survival rate.

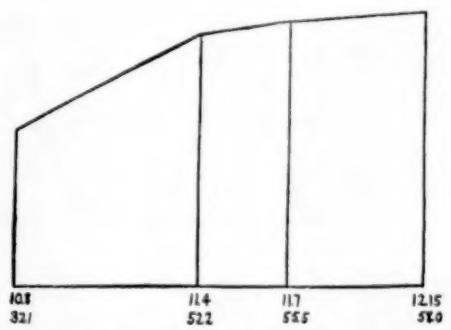

FIG. 9. The survival polygon of the length of left antennæ in female pupæ in Crampton's experiment plotted in four classes. First line of numbers, length of antenna in millimeters; second line, survival rate.

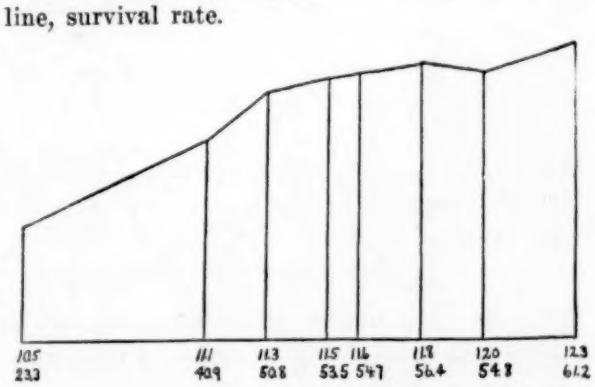

FIG. 10. The survival polygon of the length of left antennæ in female pupæ in Crampton's experiment plotted in eight classes. First line of numbers, length of antenna in millimeters; second line, survival rate.

the rate of survival changes most rapidly with the shorter antennæ.

Dr. Robert W. Hall and I have submitted *Palæmonetes vulgaris* to changed salinity. Figs. 11 and 12 show that where the marine

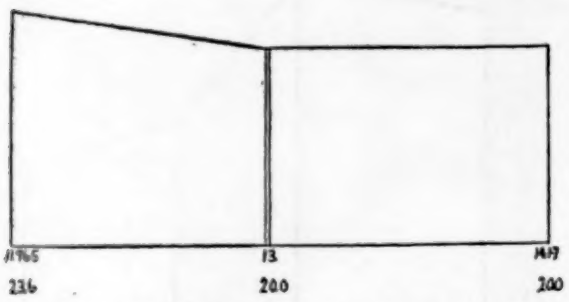

Fig. 11. Survival rate in Johnson and Hall experiment in exposing shrimp from marine salinity to fresh water. First line of numbers, number of rostral spines; second line, survival rate.

shrimps were placed in fresh water, the survival curve is higher for those of few rostral spines. Few spines is the normal condition in the fresh water species. The brackish-water strain of the marine species has also fewer spines than the typical marine species. When some of these brackish water shrimp were subjected to brine the survival curve was higher for the larger number of spines; that is, higher

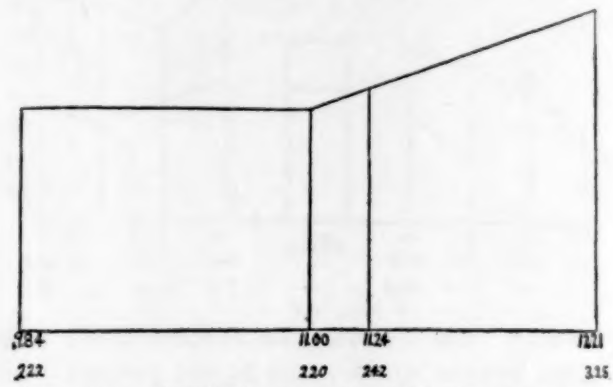

Fig. 12. Survival rate in Johnson and Hall experiment in exposing shrimp from brackish water to brine. First line of numbers, number of rostral spines; second line, survival rate.

for the marine conditions. The difference in the former case not being well marked, the experiments should be repeated on a larger scale and with greater refinements, before drawing definite conclusions. In the latter case, however, the result clearly shows selection.

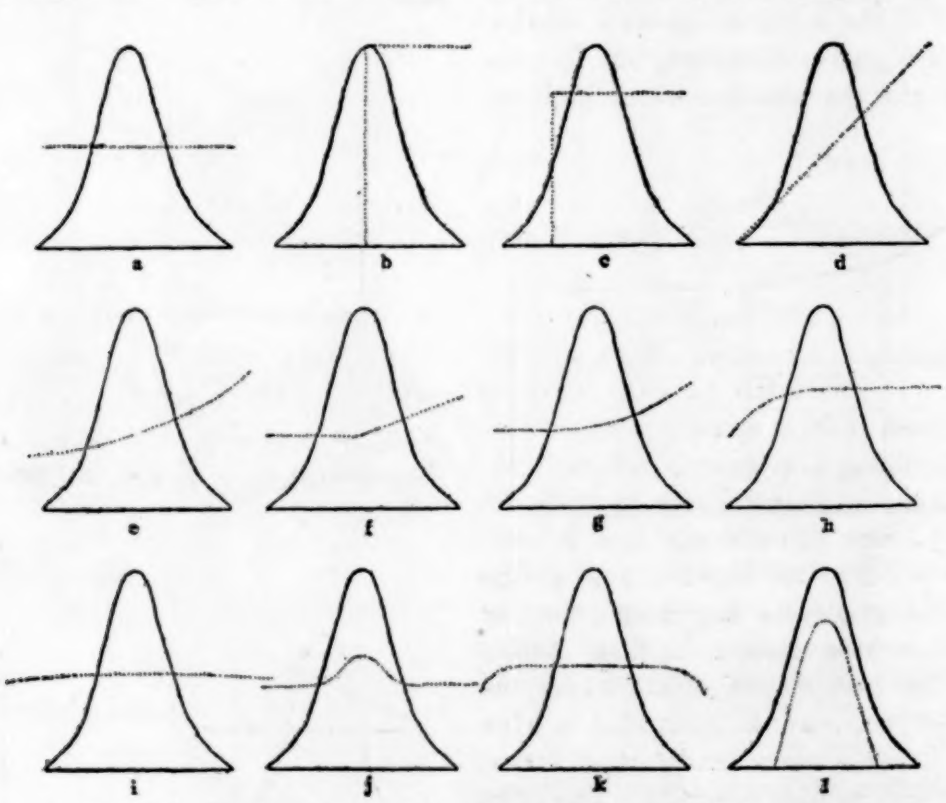

Fig. 13. Various theoretical survival curves (dotted) plotted upon a theoretical polygon of frequency.

In the use of the method in actual cases, the scale is of definite quantities. For theoretical purposes, we may plot survival on a vertical scale from 0 to 2. In this case 0 means no survival, *i. e.*, all individuals in the specified class died prematurely. At 1, we have one individual attaining the age of reproduction for each corresponding parent. At 2 we have two progeny attaining maturity for each corresponding parent. Now if the survival line is level (Fig. 13*a*) natural selection is not active; some low value in the other direction, and at some point between rise to a point or become level as in Figs. 14*b* and 14*c*. In the case of Fig. 14*c*, the species will evolve until selection becomes periodic, but in Fig. 13*b* we have a different condition. Here it is carried to a point where natural selection becomes impotent. It is in such a case that determinate evolution has free play and may, in some cases, carry the species further. In still other cases there is an absolute limit of variation in the

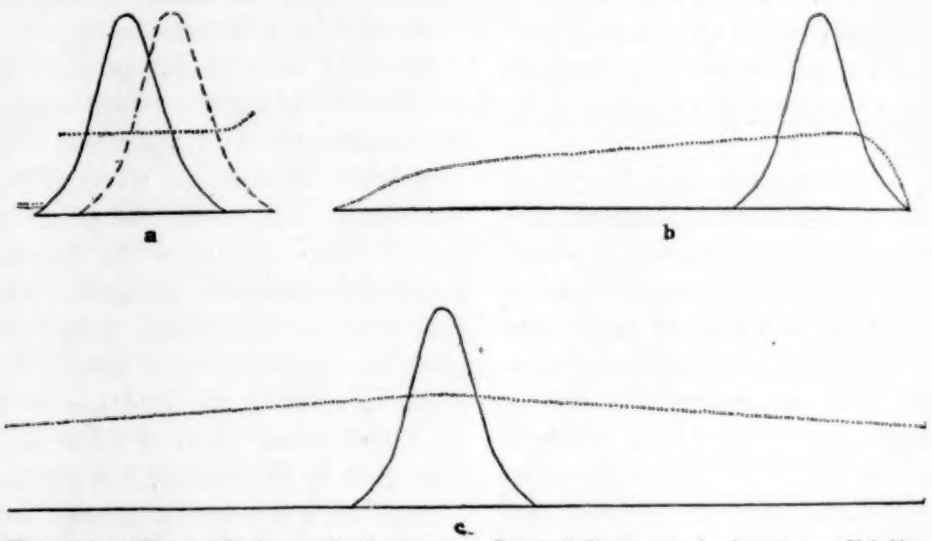

FIG. 14. Theoretical survival curves. Dotted line, survival rate; solid line, theoretical polygon; dash line, polygon of frequency of young individuals.

but if it be in any degree inclined (Fig. 13*d*) natural selection is in operation. Figs. 13*b*, 13*c* and 13*f*, I have drawn the survival curve as one would expect it from some descriptions of the action of natural selection, but such abrupt changes in the survival rate must be decidedly exceptional. The actual line is ordinarily a gentle curve, the survival rate always being low and gradually becoming lower or higher from class to class, as in Figs. 13*d*, *e* and *g–l*. The periodic selection where the species is kept stationary is illustrated in Figs. 13*i* to 13*l*. There is every gradation of course between this and secular selection. The point to which selection would carry the species might be close to the present mode.

The survival curve, if we had the data to construct it for a sufficient length, would probably, in many cases, especially those involving measurements, touch 0 in one direction and characteristic; for instance, blackish color would have a limit at absolute black (Fig. 15*b*). In such a case the survival curve would come to a sudden stop on the particular rate for that point. If the inclination is upward

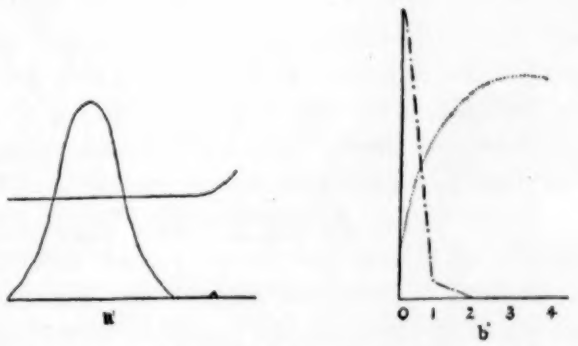

FIG. 15. (*a*) Theoretical survival curves with the mutation alone affected by a differential survival rate. (*b*) The polygon of frequency and of survival rate are limited in one direction.

toward the limit, the species must remain at the limit.

The process of natural selection must be further analyzed because of the heterogeneity of the species. A species is made up not only of individuals of two sexes in most cases, but also of individuals of various ages. This difference may affect the survival results in two different ways. The individuals of one sex may differ quantitatively so that they will be affected by differing survival rates when survival is discriminative. Because of the sexual difference, Weldon in his *Carcinus* experiment used males only, in order that it might not be necessary to increase the number to be measured.

At different ages, natural selection must often operate differently, for the characteristic changes quantitatively, and sometimes qualitatively, with age. Where the change is quantitative, the individual will change in its survival chance, where survival is discriminative. Where the change is qualitative the characteristic in question may only be in evidence during part of the lifetime. In addition to this, the survival chance may change with age, regardless of the magnitude, because of the general inefficiency of the immature. In many species, the rigor of natural selection is doubtless concentrated on the younger stages, with much decreased action later. Specific instances we have in the vital statistics of man, and in the large birds of prey, where they are not molested by man.

In experimental work, economy of effort demands concentrated attention upon adults only or upon the young of some restricted age group. Nevertheless, such a study has a serious limitation, for the whole influence of natural selection upon a species can not be known until we have an analysis of its action for every age group in the species. While the number of young individuals in the sparrow experiment of Bumpus was too small to permit an analysis along age lines, yet inspection shows that the selection was affected by age. It is quite probable that where natural selection is inoperative upon adults, it may be very efficient in some younger stages. In Fig. 14*a* I have illustrated the escape from the incidence of natural selection by age. Crampton's results with the antenna lengths of *Philosamia pupæ* might not be found to apply in imaginal life. In fact, we have the possibility that natural selection might be nullified by a reversal of action in the adult from its action at some younger stage. Thus an extra abdominal segment might be favored in the caterpillar, but penalized in the moth. Such a disparity has the effect of making the young different from the adult, ending in some cases in an elaborate metamorphosis.

It would seem that a polygon of frequency would move along a survival curve based upon the measurement of some one character until it reaches its summit, when it would remain stationary. Periodic selection would then ensue. This maintains the species at a fixed point and decreases variation. One might at first suppose that when a new structure begins, the survival curve would start at 0 and move along with the increase of the structure to a maximum. But it must be remembered that this is impossible, for the height of the theoretical curve must always have an average height of at least one, no matter what the characteristic used in the construction of the curve may be, unless the species is decreasing in abundance. Furthermore, it can get no higher than one unless the population is increasing in numbers. What we really have, therefore, when there is no change in abundance, is a compensatory depression of the whole survival curve, as the frequency polygon moves up its slope. It may be likened to a man climbing a step ladder in a descending elevator. His rate of speed might be such that his elevation would not change, but he would have horizontal motion. In this case, there would be a general depression of the survival curve to compensate for the increased survival from the increase of the characteristic in question. Elimination would necessarily become sharper at some other point, the weakest point, or at several weak points. But the elimination, discriminative with respect to this second weak characteristic, would with the first characteristic be generally distributed,

and so cause the general depression of its survival curve. For instance, let length of feather have a differential survival value, when a species of sparrow encounters colder winters. Evolution in the direction of increased feather length would cause an increased abundance of the species, unless there was a counter-influence. Such a counter-influence might be a greater mortality from shrikes, as more sparrows would thus come under their observation and engage a larger share of their attention.

The graphic method here proposed is also applicable to mutation (in the De Vriesian sense) though of less value in that connection. In such cases the mutation is plotted on the base line at the appropriate distance from the polygon of frequency and the curve of survival is extended past this point. The curve of survival may be level in the region of the polygon, but inclined outside of it, so as to affect the mutation either favorably or unfavorably (Fig. 15*a*). Or the survival curve may be inclined throughout its course, in which case the mutation does not have an exclusive advantage or disadvantage. Many of the complications referred to before are also applicable here, but further mention will only be made of the case where the survival curve is strongly inclined at the magnitude of the mutation and it is therefore strongly subjected to natural selection within its own unit in addition to its competition with the old species.

Coincident selection, which many zoologists have apparently had difficulty in understanding, is, I believe, made quite clear by the use of this method. I follow Gulick in considering Lloyd Morgan's term of coincident much preferable to Baldwin's meaningless phrase of "organic selection." In expressing coincident selection, it is only necessary to construct with the survival curve two polygons of frequency, one for the innate variation, and the other for the resultant variation after the modification by the environment.

The action of coincident selection will differ in degree according to the type of correlation of the modification with the innate variations. There may be three cases. In the first, the modification is always the same in amount, regardless of the degree of development of the innate character. This results in the transfer of the original polygon of frequency to one side or the other. Since, however, the modification would of course be some-

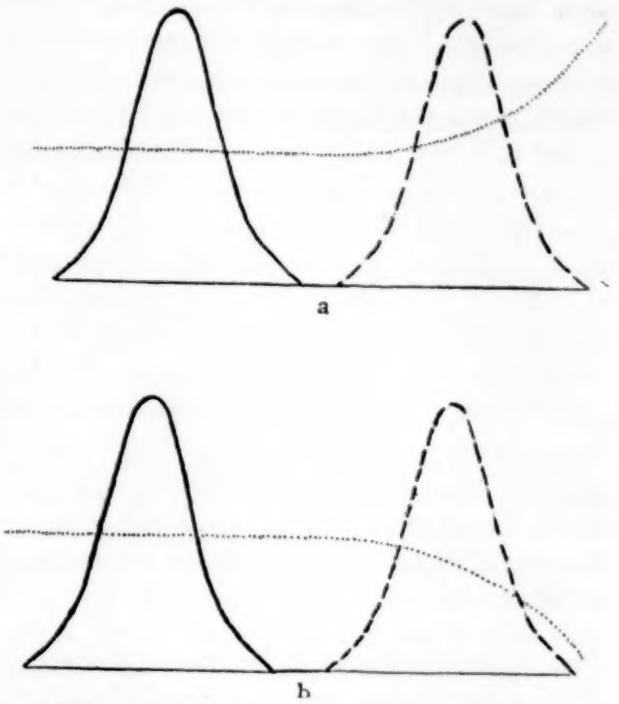

FIG. 16. The dash line polygon represents the individuals in a case of extreme coincident selection after modification. The solid line polygon represents the individuals as they would have been if not modified. Dotted lines are theoretical survival curves.

what variable, there would be some readjustment of distribution, and a corresponding increase of the variability (Fig. 16*a*). This is the case usually assumed in the consideration of coincident selection and its consequences are well known. In Fig. 16*b*, where the modification is opposed by natural selection, it may be expected to decrease in amount. In the second case, the modification is greater in those individuals which have the innate characteristic in a less degree than in those in which it was larger. Thus, elephants with an innately shorter trunk might have greater modification than others because of greater strains involved in its use. The final result in this case, then, would be the shifting of the

left end of the polygon of frequency further to the right than the right end would be shifted. This produces a narrowing of the range and decrease of variability (Fig. 17*a*). The result is a decrease of natural selection, unless the survival curve is more inclined at the new position (Fig. 16*b*). In the third case, those with the characteristic in question innately larger sustain the greatest modification. This might be illustrated in the case where only some moths which could reach the nectar of a particular flower would make con-

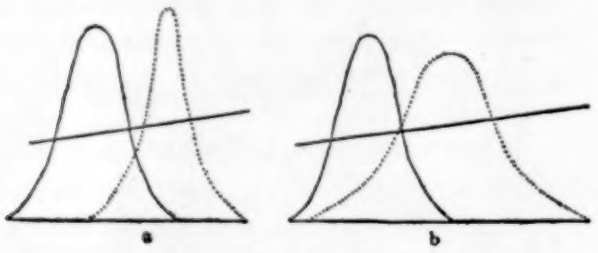

FIG. 17. The straight solid line is the survival rate; the dotted line, the polygon of the individuals as modified. To illustrate action of coincident selection in decreasing and increasing variation.

tinued effort to do so. By increasing the range (Fig. 17*b*) an increased efficiency of natural selection is produced, even though the polygon is not transferred to an increased inclination of the survival curve. It is probable that the greatest importance of coincident selection lies in its efficiency to promote incipient organs in this way, for it is easy to see how important it would be in such a case as the transformation of a somewhat prehensile snout to the elephant's trunk. On the other hand, it must, in many cases, slow up the efficiency of natural selection, when an organ has passed the "infant industry" condition, and thereby enters the second category referred to.

The study of the analyses which have been presented brings out some facts as to correlation of characters which should be mentioned here. It is often assumed that every character that is selected has a direct survival value. Some authors have recognized that a characteristic may be carried along by correlation with some related characteristic which has survival value. In these cases, the correlated characteristics are generally thought to be two distinct structures, for the correlation of which a reason is evident. It will be noticed, however, that in the case of the sparrow catastrophe, the several dimensions, aside from the length, are all selected in the positive direction and that they are all dimensions of head or limbs except the length and one body measurement, which is taken in the cephalo-caudal direction. The one characteristic not of this sort, weight, had an indifferent survival value. If we try to reason out particular advantages in each of these character changes, we are hard pressed.

Is it not probable that they are all correlated with a physiological characteristic or two, which has its external manifestation in a general increase of peripheral parts and slenderness? This is not fantastic, for we have something analogous in human pathology. The disease of acromegaly, caused by some condition of the pituitary body, produces a great increase in height and in the size of the hands and the feet. The survival value of length of antennæ in moth pupæ, the number of rostral spines of a shrimp, affected by changed salinity, are inexplicable on the basis of direct adaptation. We are driven to resort to correlation with internal features. But the frequency with which this resort to correlation is necessary in the discussion of the experiments on survival values seems significant. Even in case of the frontal breadth of the crab, where a definite value has been postulated, namely, that the narrowness of slit which permits water to reach the gills may be of importance in excluding mud, we are still dealing with a correlated character.

The multiplicity of structure that we find in animals, particularly in sculpture and markings, is simply bewildering, if we consider them all as adaptations. But with an appreciation of the great rôle played by correlation in natural selection, we should expect just such a wonderful maze of characteristics. Just as our modern insistence on the importance of the variations that offer themselves reduces the creative rôle of natural selection,

so does it become further reduced by emphasis on the importance of correlation, rather than the direct usefulness of the characteristic in question.

Of course, it is unfortunate to be obliged to find that so much of importance in evolution is not to be found in the more easily understood and investigated work of direct selection. It seems like a step backward, to be obliged to conclude that not only do we know less than we thought we did, but to also have important avenues of investigation either closed or made very difficult. It bewilders us to realize that the most fundamental factors of evolution lie in the abstruse, deep-lying problems of the origin of variations and their correlations. A gleam of promise lies in the recent induction of variations by Tower and MacDougal. Epochal as these results are, they may be said to be more the evoking of variations than the making of them. The greatest promise for light on the origin of correlation probably lies in the study of internal secretions and in the transplantation of tissues and organs.

This position in reference to correlation has its significance for the guidance of further experiments on survival values. I do not believe it is necessary to pick out obviously adapted characters for selection experiments. In proper analysis with large numbers, most causes of death will probably show discrimination with most characteristics. We may, therefore, expect to get appreciable results in aquatic animals by altering salinity or carbonic dioxide content or muddiness, and in terrestrial animals, by altering temperature, humidity, etc. On the other hand, there should be care in selecting the species with reference to the following conditions:

1. The animal should be readily obtainable in great numbers.

2. The sexes should be readily distinguishable.

3. The adverse condition should be capable of being applied evenly to any desired degree with the least possible alteration of other conditions.

4. The species should have an allied variety or species living in the new environment, which differs from it in the characteristic chosen.

5. The characteristic should be one easily measured or counted and show a good range of variation. Measurements should be ordinarily expressed in percentage of length.

6. The characteristic should not change with age, or at least not within some adult size unit to be used.

7. A further advantage lies with a species capable of being successfully bred. It may become desirable to get light upon some point by this method.

Of course natural selection is determined not by the death rate at any one catastrophe, but by the end result of the various vicissitudes that all the individuals of a species pass through from the laying of the egg to the completion of reproduction. It is therefore dangerous to conclude that the natural selection seen in any of these experiments, which all express the result of a part only of the life of the individuals, was actually producing evolution in these species. Of course, diagrams such as these must not be expected to give the entire evolutionary status of a group of individuals. We may have such a condition as shown in Fig. 17 and still have the species stationary, for the advantage in one direction may be much reduced or wholly lost by selection in the opposite direction in some other catastrophe or critical period of life. Thus, long antennæ were favored in the pupæ of *Philosamia cynthia*. It is quite possible that short antennæ might be favored in the imago, for conditions are so dissimilar. Slenderness was an advantage to sparrows in a blizzard, but compactness might be in dodgeing hawks. The lethal selection may also be counteracted by sexual or fecundal selection, modification of the germ plasm, or orthogenesis. For a time any one of these influences may even force the species in the opposite direction to that in which lethal selection is impelling it.

The relation to orthogenesis is especially

interesting. Orthogenesis is a progressive variation or biased heredity in a given direction in successive generations. It is not a constant process, but one which is active in a certain characteristic in a particular species for a limited time, while most other characteristics are untouched by it. Let us call one of these lines of orthogenetic activity an "orthogenetic run" after the analogy of the "run" on a special line of merchandise which merchants occasionally experience. In such an orthogenetic run the individual steps are often not affected by selection up to a certain point, or only to so slight a degree as to be relatively negligible. But a "run" may eventually reach the threshold of a decisive selective value. Natural selection will then stop the course of the run. The "run" may be eradicated from the species, or when it is too persistent to be eradicated, then the species will be exterminated, as I imagine has taken place in the Irish elk and in the excessively spiny species with which many extinct mollusc genera have culminated.

But the result of such continued checking of inimical runs and the tolerance of other neutral or beneficial runs is to determine to some degree the kinds of "runs" that will arise in the future. Thus "runs" dealing with distribution of hair and hair modifications in great variety have been tolerated or encouraged, so that runs of this kind became commoner. On the other hand, runs affecting the chemical constitution of the red blood corpuscle once it had reached the vertebrate standard have been so promptly checked that variation in this characteristic has been checked and a high degree of conservatism resulted.

The analysis of the experiments given has a further value in its bearing on the question of the possible selective value of minute variations. Indisputably there has been too general a faith in widespread selective values in the past. At present, however, we can see evidences of an unjustifiably extreme reaction. In the consideration of selective values, critics have been wont to compare two adjacent classes of the frequency polygon and to descant on the improbability of a selective value. A safer viewpoint is to consider the chances of two classes not immediately adjacent. If a selective value is found between some two classes, we may be fairly sure that the selective value will not end abruptly, but become less step by step in passing from one class to the other. It is absurd to expect a high survival rate in one class and a low one in the next. In almost all cases we must expect the survival rate to gradually increase or diminish from class to class. This is the verdict of the experiments. It is idle to talk about the impossibility of selective value of minute differences, when it is possible to measure and analyze them.

The object of this paper has been to develop the method of analysis of natural selection by the construction of survival curves, in order, first, to extract more meaning from the experiments already performed, but second, and especially to encourage further selection experiments by making it possible to obtain more significance from them. Its publication has been delayed four years that the author might add some applications of the method. Occupation upon another line of research makes its publication necessary now without such results in the hope that they will be supplied by others.

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SPECIAL ARTICLES

BOTANICAL EVIDENCE OF THE AGE OF CERTAIN OX-BOW LAKES

In the southeasternmost county of Arkansas, near the Mississippi River, there is a crescent-shaped ox-bow lake about 15 miles long, of a type frequent in the flood-plains of large sluggish rivers, known as Lake Chicot. Lake Village, the county-seat of Chicot County, is located on the side farthest from the river, and the railroad from that point to Luna Landing on the Mississippi skirts its northern bank for a few miles. At present the shores of this lake are mostly pastured, but at

the water's edge on both sides, where it is visible from the railroad at least, it is bordered by a thin fringe of small cypress trees (*Taxodium distichum*).

Observations on this tree in all the southeastern states and in fourteen different years have led me to believe that it is rarely or never found on the banks of rivers or other bodies of water which have an average seasonal fluctuation of more than ten or twelve feet. Its trunk usually emerges from the ground just about low-water mark, and its enlarged base and "knees" are generally believed to reach up approximately to the average level of high water;[1] the figures just mentioned being about the maximum height recorded for these excrescences. Now the Mississippi River in the latitude of Lake Chicot has a seasonal fluctuation of about forty feet, and the cypress is absent from its immediate banks, though visible from the river in some places where it grows in nearby sloughs not directly connected with the main channel.

Presumably, therefore, when the waters of the Mississippi flowed through what is now Lake Chicot the cypresses which fringe the lake to-day did not exist. When the lake was cut off from the river, in the manner described in all treatises on potamology, its seasonal fluctuations were of course at once greatly reduced, and conditions then became suitable for the growth of the cypress on its banks. Consequently if one could determine the age of the oldest of these trees, by counting the annual rings or otherwise, that would give a minimum estimate of the age of the lake. As I have seen this lake only from the train, I have no data about the annual rings of its cypresses, but there is some evidence of another sort that they are comparatively young for that species.

Young cypress trees, of either species, are spindle-shaped in outline, much like the typical conventional conifers of the cooler parts of the northern hemisphere, while mature individuals are always more or less flat-topped, a character by which they can often be distinguished from other trees at a distance of several miles.[2] At just what age *Taxodium distichum* reaches its maximum height and begins to develop a flat top has not been determined, but very likely it is between 100 and 300 years.[3] The cypresses of Lake Chicot are mainly spindle-shaped, and perhaps date back only to the eighteenth century.

This supposition could easily be tested by a visit to the place in question with suitable tools. At the same time the cypresses bordering other ox-bow lakes along the Mississippi, especially those lakes whose age is a matter of historical record, should be examined from the same point of view. Additional evidence might be gathered from other swamp trees, especially the tupelo gum, *Nyssa uniflora*, which is common in sloughs and rare or absent on river-banks, bearing about the same relation to seasonal fluctuations of water that *Taxodium distichum* does. But the cypress is best for this purpose, on account of its longevity.

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[1] See *Bull. Torrey Bot. Club*, 32: p. 108, 1905.

[2] Hilgard ("Soils," 507–508, 1906), Cowles ("Ecology," 734, 1911), and some other writers have noted that the cypress when growing in uplands, such as parks, is spindle-shaped (see illustration in *Rep. Mo. Bot. Gard.*, 15: pl. 16, 1904), and have tried to correlate shape with habitat. C. S. Chapman (U. S. Bureau of Forestry, Bull. 56: 41–42, 1906) ascribes the flat top of cypress in Berkeley County, South Carolina, to the disease known as "peckiness," while Cowles, in the work cited, considers the flat-topped trees dwarfed on account of "the imperfect absorption which is characteristic of swamps." But age alone would seem to be a sufficient explanation of the difference in shape, since there is no doubt that all the younger trees, whether in their native swamps or in parks, are spindle-shaped, and the largest individuals known are flat-topped.

[3] The species has been known to civilized man only about 300 years, and presumably none of the existing cultivated specimens are old enough yet to have lost their juvenile form.

ON COMPARING AMMONIFYING COEFFICIENTS OF DIFFERENT SOILS

IN a recent publication[1] Professor W. G. Sackett gives some interesting results of a

study of the ammonifying powers of some Colorado soils, among them some of the now well known "niter soils" and some of the normal soils of the state. In concluding the discussion the author attempts a comparison of the ammonifying powers of soils from different states with his own, in which he quotes data on the subject obtained by J. G. Lipman as regards New Jersey soils, F. L. Stevens and coworkers as regards North Carolina soils and the writer as regards a California soil. From the comparison Sackett concludes that the niter soils of Colorado show a much higher ammonifying efficiency than soils from other states and than the normal soils of Colorado.

Despite the fact that Professor Sackett makes some qualifying statements in discussing the comparisons, he does not seem to attach importance enough to some factors of which he appears to be fully cognizant, and gives no consideration to other very important factors. The writer of this note fails to appreciate the value of a comparison of the ammonifying powers of various soils as obtained by different investigators whose methods vary as much as ours do to-day. Not only is it true, as Professor Sackett points out, that the time of incubation may be responsible for *some* of the differences found between his normal sandy loam and the one with which I worked, but differences of great magnitude can easily be obtained in changing the length of the incubation period, as J. G. Lipman has repeatedly shown in his long series of investigations on ammonification at the New Jersey Experiment Station. Moreover, the writer has found different brands of dried blood to vary so much in composition, both physically and chemically, that no fair comparison can be made without employing not only the same period of incubation and the same temperature for all soils but also the same kind of dried blood.

Other important factors also militate against a useful comparison of the ammonifying powers of different soils as obtained in laboratories varying widely in their methods of studying such problems. For example, Professor Sackett sterilizes his soils with mercuric chloride and then rinses them with sterile distilled water prior to inoculation with a *soil infusion*. In my laboratory soils are used directly for cultures without the use of a soil infusion. Others may use either procedure or both. I fail to see how one can safely compare the flora of a soil in its natural condition with a partial flora introduced through a soil infusion. The act of sterilizing a soil has been amply shown to be favorable to nitrogen transformation, but if in addition to that the soil is rinsed with water, it is obvious that the culture medium may become an entirely different one and yield a different ammonification coefficient from the same soil unsterilized or unrinsed. A soil infusion equivalent to 5 grams of soil may give a very far different bacterial development, possessed of very far different powers from the whole flora of 100 grams of soil. It must also be added here that the comparison of only a few soils can not be invested with much importance even if the soils are described by similar names. It is of course obvious that sandy loams may embrace soils of very widely differing natures and that no just comparison can be made between a sandy loam so called in one district with a sandy loam so called in another district.

As to the ammonification coefficients of niter soils as compared with those of normal soils the writer begs to add that he has on several occasions noted a high ammonifying power in soils of this state containing abnormal amounts of nitrate and has attributed that not only to a partial denitrification of the nitrate but also to an enormously increased development of putrefactive organisms in these soils which always produced large amounts of ammonia. I have also noted the same thing on two niter soils derived from the vicinity of Grand Junction, Colorado.

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[1] Bull. No. 184, Colorado Experiment Station, Part 1, June, 1912.